Technical Report 1155

Dismounted Infantry Decision Skills Assessment In The Virtual Training Environment

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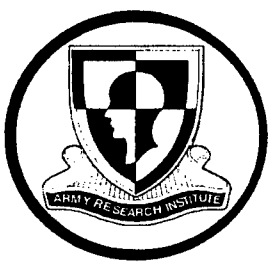

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14. ABSTRACT *(Maximum 200 words)*:
This report was developed under a Small Business Innovation Research Program, Phase II. The Virtual Soldier Skills Assessment (ViSSA) is a software system that operates in a DIS/HLA-based virtual environment. ViSSA can automatically detect significant events in virtual exercises. It also has a logger/playback module to allow to assist the trainer or Observer/Controller (O/C) in highlighting these significant events during the after action review (AAR) The system is designed to assess warfighter skills, decision-making, and situational awareness. Event/Condition/Action rules are designed by experts for consistent assessment against Doctrine. ViSSA can reduce training and assessment costs by minimizing the burden on the O/C and assisting in orchestrating an effective AAR by providing the rapid replay of significant events, summary statistics, and critical decision points during the exercise. Training for urban operation missions is limited by time, cost, and safety factors. Virtual environment technologies like ViSSA have the potential to provide the Army with a training capability to meet these demands to optimize human performance by enhancing Soldier decision-making skills.

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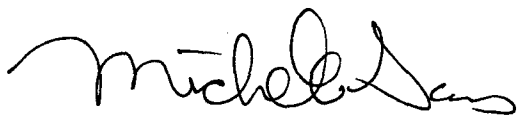
FOREWORD

ScenPro has been working with the U.S. Army Research Institute for the Behavioral and Social Sciences (ARI) Infantry Forces Research Unit at Fort Benning to develop and field the Virtual Soldier Skills Assessment (ViSSA) system. The ViSSA system is an automated training, assessment, and after-action review tool for virtual simulations. It assists the Observer/Controller in preparing dismounted forces for critical decision-making situations during military operations and providing mission rehearsal for operations in urban environments. ViSSA tracks mission-related factors linked to Soldier decisions, movements, rounds fired, contact with virtual entities, and time factors using the protocol data unit (PDU) information packets generated by entities during the simulation. The PDU packets provide information about an entity's status, position, heading, and how and where the entity should be displayed in the virtual environment. The key research thrust of this SBIR was to investigate ways to assess Soldier decision making skills using primarily data available via the PDU packets. The result is a training and analysis system that can accurately monitor Soldier performance and quickly summarize strengths and weaknesses, as defined by the trainer, across key performance dimensions. Individual project goals to increase leader responsiveness to environmental stimuli, situational awareness, and mental agility to make sound leadership decisions are incorporated into the ViSSA system design. These characteristics support concepts for the Objective Force and complement the Future Combat Systems program.

This research was funded by ARI as a Department of the Army Small Business Innovation Research Phase II award entitled *Assessing Decision-Making Skills in Virtual Environments*. The final results from the Phase II effort and a system demonstration were provided to the Chief of the Virtual Simulation Lab and key staff members in November 2003. The ViSSA system is currently installed and operating at various facilities within the Soldier Battle Lab at Fort Benning, Georgia.



MICHELLE SAMS
Technical Director

DISMOUNTED INFANTRY DECISION SKILLS ASSESSMENT IN THE VIRTUAL TRAINING ENVIRONMENT

EXECUTIVE SUMMARY

Research Requirement:

ScenPro, Inc. has developed the Virtual Soldier Skills Assessment System (ViSSA) in cooperation with the U.S. Army Research Institute for the Behavioral and Social Sciences (ARI) through Phase II Small Business Innovation Research (SBIR) funding. ViSSA is an automated training, assessment, and after-action review support system designed to assist in preparing dismounted forces for decision-making in urban operations, using the strengths of virtual environment technologies.

The U.S. Army is investigating the use of virtual environment (VE) training. Currently, the VE training facilities for dismounted infantry are envisioned to be similar to the Soldier Battle Lab (SBL) located in Fort Benning. Due to the complexity of the VE, observer/controllers (O/C) are forced to spread their attention across many areas during an exercise. O/Cs need automated support that enhances the training environment.

The ViSSA prototype system was designed to enhance the O/C's ability to monitor and train cognitive decision-making skills through the execution of missions by small unit leaders (platoon, squad, and team) in the virtual environment. In particular, ViSSA automatically identifies significant events, logs all Soldier movement and behavior, and provides focus during after action reviews (AAR).

Leader trainees command a platoon, squad or fire team during a series of realistic training missions in the virtual environment, leveraging the safety and adaptability offered by virtual technology and enhanced by ViSSA assessment capabilities and multi-media after-action reviews. The result is a comprehensive training system that assesses decision-making and team coordination skills, yet requires a low level of personnel support for O/C functions, subordinates, and role players by using the computer-controlled or semi-automated forces that represent subordinates, friendly forces, enemy forces, and civilians.

The research goals for this effort were threefold: 1) to design an automated prototype system capable of accepting predefined assessment criteria from the O/C during the staging of the virtual exercise; 2) to develop a methodology for capturing and linking key leadership decisions to observable commands, infantry tactics, and/or communications established by the virtual training objectives; and 3) to develop a means of displaying decision-making shortfalls and successful execution of training objectives in real-time and immediately following a training exercise to provide pertinent feedback to Soldiers during the after-action review.

Procedure:

Research into legacy systems literature and current development studies provided opportunities to identify compatible virtual environment technologies for integration and future development and research. The ViSSA development team observed, tested, and participated in virtual training

exercises and experiments at the SBL to understand the state-of-the-art in virtual environment technologies. In addition, research conducted at the Close Combat Tactical Trainer facility provided insights and understanding into the interaction of computer-driven, manned, close combat heavy vehicle simulators (e.g., M1A1 tank and M2A2 Bradley Fighting Vehicle) combined with computer generated forces operating together on a virtual battlefield.

In order to fulfill the requirements, the OneSAF Testbed Baseline (OTB) software, DISAF, Soldier Visualization Station software, ASTi™ Digital Audio Communication System (DACS), Distributed Interactive Simulation (DIS) protocol, and High Level Architecture (HLA) protocol, which are used at the SBL, were evaluated for integration with the SBL. The ViSSA system does not attempt to replace or interfere with existing software components providing the 2-D and 3-D graphical representations of the simulation. Instead, the ViSSA Assessment module monitors network traffic, internalizes the movement and behavior of the Soldiers, and automatically detects significant events. Concurrently, the ViSSA Logger module captures and logs all entity protocol data units (PDU) packets while the ViSSA Audio Logger module captures and logs all DACS-based communications packets. This design allows ViSSA to operate with almost any virtual environment software that communicates via (PDU) packets across a DIS/HLA network and ensures ease of integration as virtual environment software graphics and technologies continue to evolve.

Subject matter experts (SMEs) in the areas of training, urban warfare, and virtual environment system operation participated throughout the development effort. Contributions from the SMEs pointed towards a rule-based expert system to monitor behavior to identify significant events for AAR. This user-driven approach provided a firm foundation for a functional system design that employs a flexible schema of logic for implementing assessment rules in ViSSA. The schema is known as **Event/Condition/Action (E/C/A)** and is a variant of traditional production rules that accommodates both the real-time and reactive requirements of the simulation environment. Every action and behavior of an entity within the simulation produces an **Event**. Events cause blocks of software (VBScript) containing one or more conditions to be evaluated. If the **Conditions** are met, then the resulting **Action** takes place. The specific **Events** supported by ViSSA include movement, firing a weapon, change of posture, communication, and any other behavior that is communicated across the DIS/HLA network. In addition, ViSSA allows the O/C to predefine observations that cannot be detected and communicated via the DIS protocol. The system is capable of combining and reasoning over both computer and human detected events. A **Condition** is a Boolean expression triggered by the **Event**. Examples of this include checking if the Soldier entered a specific building, ducked under a window, or used a certain type of weapon. The resulting **Action** can be as simple as directing the system to mark a point on the exercise timeline for later review, or starting a timer to measure reaction time to enemy fire. A complete example of E/C/A would be the following: an **Event** is created by a Soldier firing his weapon, the **Condition** is met by targeting an Opposing Force, and the resulting **Action** is placing a mark on the exercise timeline indicating the sequence should be reviewed during the AAR.

The E/C/A Assessment module of ViSSA is built by combining the Microsoft Visual Basic™ Scripting Engine with a ViSSA COM Automation Object Model. Because the existing OTB logger was not suitable, a Logger module was developed to provide many features that go beyond traditional DIS PDU loggers and to provide integration with MS Office products. Finally, an Audio Logger was developed to synchronize the audio with the data of the exercise. Each module is designed to run on a separate mid-range WinTel computer running Windows 2000 (or later).

Findings:

Initial capabilities assessments by BattleMasters and support staff at the SBL indicate that the ViSSA system supported the assessment of decision-making skills to small unit infantry leaders. The flexible features and functionality of ViSSA support exercise monitoring and the statistical analysis work routinely performed at the SBL.

The improvements provided to the SBL by the addition of ViSSA are the result of developmental efforts designed to complement the software and databases used at the lab to generate the 3-D virtual environment, not duplicate it. Significant accomplishments include the ViSSA E/C/A rule schema with additional user interfaces designed to define, sort, filter, and display captured data, real-time exercise monitoring, and a Logger coupled with a synchronized Audio Logger. To ensure that the ViSSA system could achieve required performance levels, experiments were conducted at the SBL throughout development with experts on staff. The Logger/Audio Logger modules were used to capture PDU traffic during execution of infantry training exercises. The Logger module was invoked whenever an E/C/A rule fired causing an annotated timestamp to be written to a data file. Radio communications data passed between the squad leader, the O/C acting as platoon leader, and fire team leaders were also captured by the Audio Logger for synchronized exercise playback. The results of the evaluation demonstrated the system could easily achieve the demanding performance requirements of multiple entities operating in the virtual environment. The ViSSA system is currently installed and operating at three facilities within the SBL. It is used on a regular basis by the SBL staff to log and monitor exercises and produce statistical data.

Utilization of Findings:

The features and functionality of ViSSA have demonstrated immediate application for Future Combat Systems program research at the SBL. ViSSA provides enhancements to the SBL software configuration currently used at the lab, making use of the graphical displays provided by OTB with additional features that apply meaningful data output and statistics to the execution of simulated missions in the virtual environment. ViSSA also provides an efficient, cost effective way to monitor and assess virtual environment training while greatly easing the burden on the O/C. These capabilities are enhancing the U.S. Army's ability to train decision-making skills to dismounted, small unit leaders (platoon, squad, and team) in virtual environments.

The SBL participates in the validation of ideas for the Future Force close-fight battle. The force structure and the concepts for how the Army will shape the close fight, and how the Army will set the conditions for decisive victory, are being analyzed and refined using state-of-the-art modeling and simulation. Due to its relatively extensive use within the SBL, the ViSSA system has proven capabilities in training and assessment.

DISMOUNTED INFANTRY DECISION SKILLS ASSESSMENT IN THE VIRTUAL TRAINING ENVIRONMENT

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Introduction

Dismounted Soldier Training and Mission Rehearsal in the Virtual Environment

The military forces of the United States must increasingly prepare for a full spectrum of operations in urban environments (U.S. Department of the Army, 2003). This significant change from previous decades of rural combat deployments has resulted from the emergence of urban guerrilla and state-sponsored terrorism. Maintaining superiority in urban areas is often key to the control of important resources. Early seizure and control of these areas support military objectives and successful follow-on operations.

The emergence of advanced computer systems and computer-generated models has set the stage for using cost-effective, realistic simulations to complement urban operations training facilities and better prepare the military for combat in these environments (Sylvester, 2000). The most advanced of these models includes the ability to generate a virtual environment (VE) that resembles real world terrain conditions. The VE offers significant potential for simulation options that are transportable and can be adapted to simulate areas of future operations.

Figure 1 shows how VE training can best be utilized to enhance traditional training methods. Previous research (Pleban, Eakin, Salter, & Matthews, 2001; Pleban & Salvetti, 2003) demonstrated that VE training for urban operations offers some significant advantages. These benefits are mainly in the cognitive areas of planning and strategy, decision-making, and team building. The VE supports mission rehearsal for the experienced Soldier that is otherwise very costly, involves safety issues, or requires frequent repetition. Using a VE, Soldiers can experience a wide variety of terrains and situations in a single day. The training exercises can

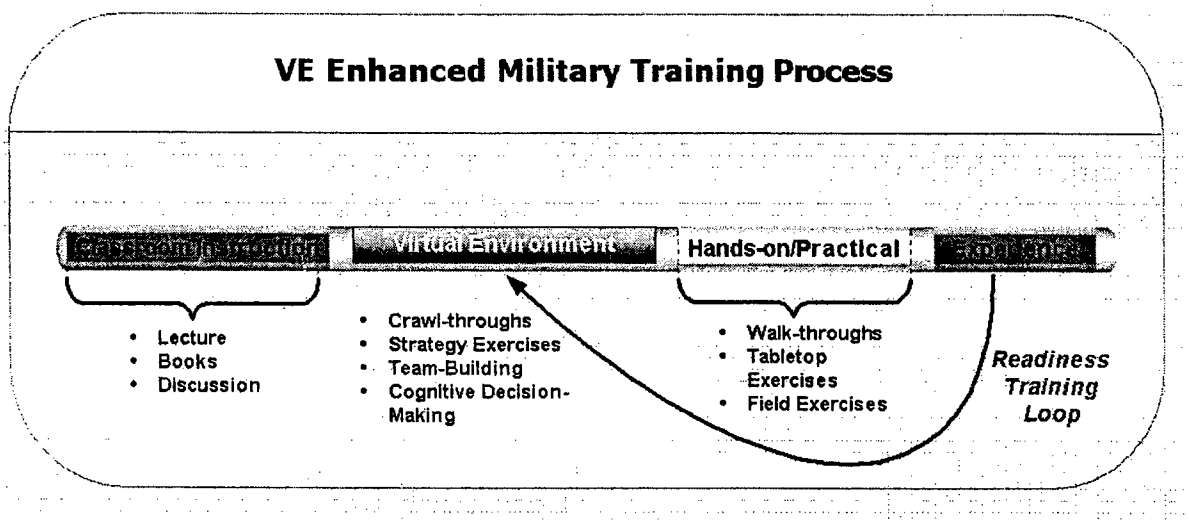

Figure 1. Virtual environment augmentation of traditional training methods.

range from simple, single task situations to complex, multi-faceted missions including high levels of (simulated) danger and complex decision-making requirements.

Training and Assessing Small Unit Leader Decision-Making

The United States military training methodology is based on the "crawl...walk...run" concept (U.S. Department of the Army, 1996). This concept of training is especially successful at teaching the critical, cognitive decision-making skills required of Soldiers and small unit leaders. This methodology breaks down information into small, easily learned segments. The tempo, quantity, and complexity of the information presented are increased as the trainee demonstrates understanding and/or mastery of the skill set being taught.

During preparation and planning for a mission, leadership and team members typically construct a baseline plan for operations and decision-making. These plans are composed of combinations of pre-structured task sequences they have been trained to execute. These are referred to as tactics, techniques, and procedures (TTPs).

Designing a mission plan based on well-practiced TTPs allows commanders to make rapid decisions in the face of complex and dangerous circumstances. As long as the cues or patterns encountered by the force support the application of a familiar TTP, leaders coordinate team actions with little need to weigh one decision over another.

In contrast, when the circumstances are new, novel, or unexpected, they require deliberate decision-making. This deliberate decision-making takes time and can divert focus from key events and cues occurring in the mission environment. It is impossible to duplicate the experience of every possible situation that might be encountered using virtual simulation. However, a representative set of real-world experiences can be mastered and retained for future mental reference.

It is difficult, however, to determine and assess the cognitive processes going on inside someone's mind. The primary purpose of this Phase II Small Business Innovation Research (SBIR) project was the successful design and deployment of a prototype system to assess the cognitive decision-making skills of dismounted, small-unit (platoon, squad, or team) leaders in virtual urban environments. The Virtual Soldier Skills Assessment (ViSSA) system is the operational prototype resulting from this effort. ViSSA is capable of inferring decision making based on observable actions with sufficient flexibility to handle the rapidly changing situation encountered in Military Operations on Urbanized Terrain (MOUT).

Prototype Software Requirements, Design and Development

Development Process

ScenPro applied the Scenario-based Engineering Process (SEP) (Harbison & McGraw, 1997) to this development effort. SEP is a methodology originally developed by the University of Texas at Arlington. The Scenario-based Engineering Process is ideally suited to programs

that have multiple users with differing roles; evolving, hidden, or hard to characterize user requirements; and information requirements that are difficult to capture. A graphic representation of the SEP process is show in Figure 2. In this development effort, we applied all three Phases of SEP: Domain Analysis, Application Analysis, and System Implementation.

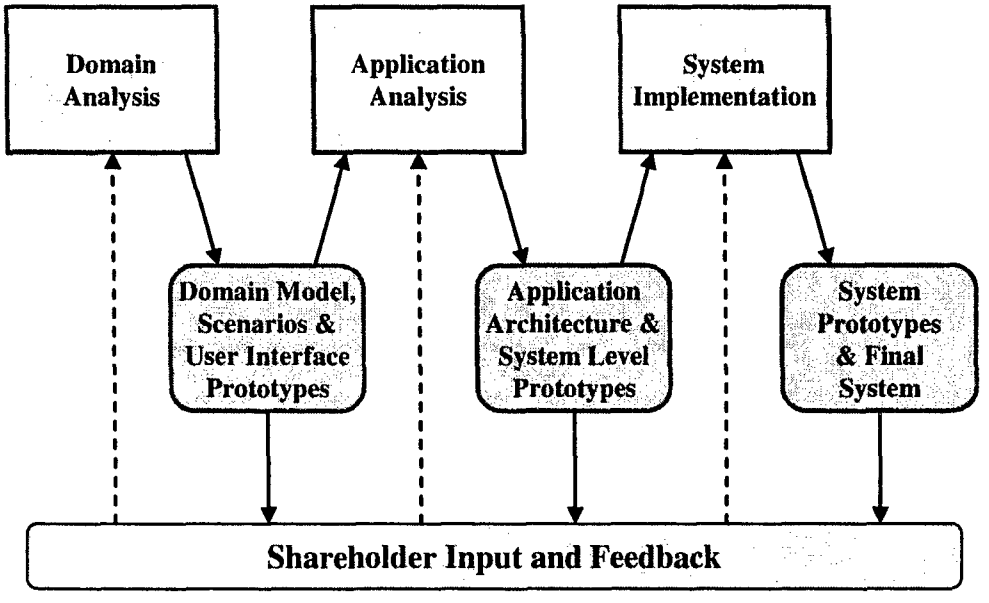

Figure 2. Scenario-based Engineering Process.

Domain Analysis

The Domain Analysis phase of SEP focuses on analyzing and understanding the problem domain. This begins by evaluating the existing processes, technology, and tools. Next, Scenarios of Use are created with the help of subject matter experts and users. These scenarios cover both the way things are currently done in the domain and how the shareholders envision it could be done in the future. Finally, the scenarios are analyzed to understand tasks, data flow, and constraints.

In support of Domain Analysis, ScenPro knowledge engineers looked for existing automatic (virtual world) event detection systems and systems to automatically support after action reviews. The Automated Training Analysis and Feedback System's (ATAFS) (Brown, Wilkinson, et al., 1997) goals were to demonstrate the capability to provide AAR leaders a menu of automatically and manually generated aids for use in the AAR within 10 minutes after the end of a simulation exercise. The ATAFS was able to meet this goal by employing platforms with multi-tasking capabilities and by using a knowledge database to automatically generate AAR aids during exercises. As a result, the ATAFS was able to provide a bin of candidate AAR aids available for use at ENDEX.

ScenPro knowledge engineers also spent time at the Ft. Benning and Ft. Leonard Wood to understand the Army Soldier training and assessment process, the Army leader training and assessment process, the Army after action review (AAR) process, the Soldier Battle Lab

(SBL), and the specific hardware and software components within the SBL. The following hardware and software technologies were analyzed:

OneSAF Objective System (OOS). The Program Executive Office of Simulation, Training, and Instrumentation (PEOSTRI) has developed a set of software modules and applications that may be used as a baseline for constructing Distributed Interactive Simulation (DIS) and Computer Generated Forces (CGF) applications. The OneSAF Testbed Baseline (OTB) applications were developed specifically to provide a vehicle for development, integration, testing, and user feedback of technology developments for the Objective System. These interim versions of VE software are prototype steps in a 5-7 year development plan by PEOSTRI to consolidate and standardize the Army's VE products.

Dismounted Infantry Semi-Automated Forces (DISAF) 8.0/9.4. DISAF simulates entities for DIS-based virtual environments that are sufficiently realistic to cause the illusion that the displayed vehicles and semi-automated forces (SAF) are humans, rather than computers. These entities, which include ground and air vehicles, individual combatants, missiles, and dynamic structures, can interact with each other and with manned individual combat simulators to support training, combat development experiments, and test or evaluation studies on the virtual battlefield. DISAF, like OTB 1.0, is derived from Modular Semi-Automated Forces (ModSAF). DISAF enhancements have been migrated into the OTB 2.0 software distributed and supported by PEOSTRI

Soldier Visualization Station™. The Soldier Visualization Station (SVS) is a state-of-the-art, high fidelity, individual combatant, virtual simulation system. It works with DIS-based virtual environments. It provides 3-D graphics, directional audio portals, and a screen projection user interface into the virtual environment (Pleban, et al., 2001). A single Soldier is "instrumented" by wearing a helmet with radio frequency sensors on it. He/she is equipped with a radio and simulation rifle that is networked to a control center computer. Detectors in the room determine the Soldier's location and posture. The Soldier Battle Lab has more than 80 stand-up SVSs and many more desktop SVSs. There are also desktop versions of the SVS that allow the Soldier to use a simple joystick to participate in the VE. This allows involving more humans into an exercise at a much lower cost and is especially useful for role players when CGFs are inadequate.

Digital Audio Communication System (DACS). Advanced Simulation Technology, inc. (ASTi) developed the DACS for simulation and training environments. It is a modular, scalable software and hardware architecture that simulates a wide variety of radio networks and conditions. It operates in DIS and High Level Architecture (HLA) network environments. An extensive ASTi simulated communications system was installed at the SBL that provides 188 full-fidelity simulated radios and supports 185 operator positions distributed throughout three warehouse-sized buildings covering an area roughly equivalent to on city block.

Dismounted Infantry Virtual After Action Review System (DIVAARS). The Institute for Simulation and Training (IST) at the University of Central Florida developed this virtual simulation logger and playback system. DIVAARS provides a real-time 3-D graphic display (stealth view) of the exercise and during the AAR.

The BattleMasters and technical staff at SBL provided a comprehensive understanding of the virtual environment software and databases, network configuration, and expectations for integrating the prototype ViSSA system. This involved extensive knowledge acquisition and observation of the tasks, events, interactions, individual roles, and outcomes expected during an assessment exercise. Ultimately, the end user requirements for development of the ViSSA system were defined and refined. Requirements focused on the needs of three different user groups:

- U.S. Army trainers, who understand the skills required for mission success as well as the process of training and assessing Soldiers and small unit leaders.
- The BattleMasters and Observer/Controllers (O/C), who will interact with the VE software user interfaces to stage the assessment exercise and work with the trainer to effectively capture and annotate decision points within the scenario where the Soldier performed above or below the expected skill level.
- The trainee, who will be briefed about the mission prior to entering the virtual world and then provided with a comprehensive after-action review. The AAR should include all participants as a team-building exercise, where they may learn from the mistakes of all team members and share together in the victory of a successful mission.

Application Analysis

The Application Analysis phase of SEP uses the domain model, developed during Domain Analysis, to enumerate requirements and design an application that meets all requirements, constraints, and user expectations. This design task can include trade-off studies and algorithm development efforts.

The key requirement of ViSSA was to automatically "detect significant events" in the exercise related to small unit team leaders' cognitive decision-making skills.

In support of the key requirement to "detect significant events," the following additional requirements were identified to create a usable system:

- Minimizing the burden of the O/C
- Supporting after-action reviews – which requires logging and replaying all exercise Protocol Data Unit (PDU) packets
- Allowing the trainer to use legacy 2-D and 3-D visualization to loop over significant events to aid in making training points
- Capture and playback of synchronized audio (inter-Soldier radios)

Additional exercise monitoring functionality required by trainers, Battlemasters, and O/Cs includes:

- Capturing and displaying real-time statistics about weapons use, wounding, kills, and fratricides

- Capturing and displaying high-level status information about SVSs, radios, and SAF programs

Additional post-exercise analysis functionality required by researchers includes:

- Exporting PDU data to a database for later analysis
- Exporting statistics to a spreadsheet for later analysis
- Exporting high-level event information to a text file – providing a high level flow of the events of the exercise

Trade-off studies evaluated different architectural approaches and determined that complementing existing PEOSTRI software and using overlay graphics to define areas of interest related to decision-making provided the most viable option for capturing Soldier decision-making within the virtual environment. This required a careful review of OTB (versions 1.0 and 2.0) and DISAF (versions 8.0 and 9.4) software and documentation produced by PEOSTRI.

The key system design considerations included:

1. Leveraging existing technology and tools.
2. Compatibility with the SVS.
3. Compatibility with PEOSTRI OTB 1.0/2.0 and DISAF 8.0/9.4 software and dynamic terrain database.
4. Minimize the requirements placed on the O/C.
5. Possibility of holding the exercise and AAR in different locations.
6. Ensure system can scale from a single Soldier to thousands of Soldiers and SAFs yet be controlled by a single O/C.
7. Assumptions about a Soldier's decision-making skills must be drawn primarily from his/her actions. Specifically, the direction they choose to walk, what posture they use, how quickly they react, where they fire, and how they direct their squad or teams to respond.
8. The Soldier's squad may be human beings assigned to a specific role in the SVS, or they might be SAF Soldiers operating under control of the O/C.

The final design of ViSSA resulted in three software modules: Logger, Audio Logger, and Assessment. Figure 3 shows the ViSSA Environment Diagram indicating how the ViSSA components interact with each other and with other components in the SBL.

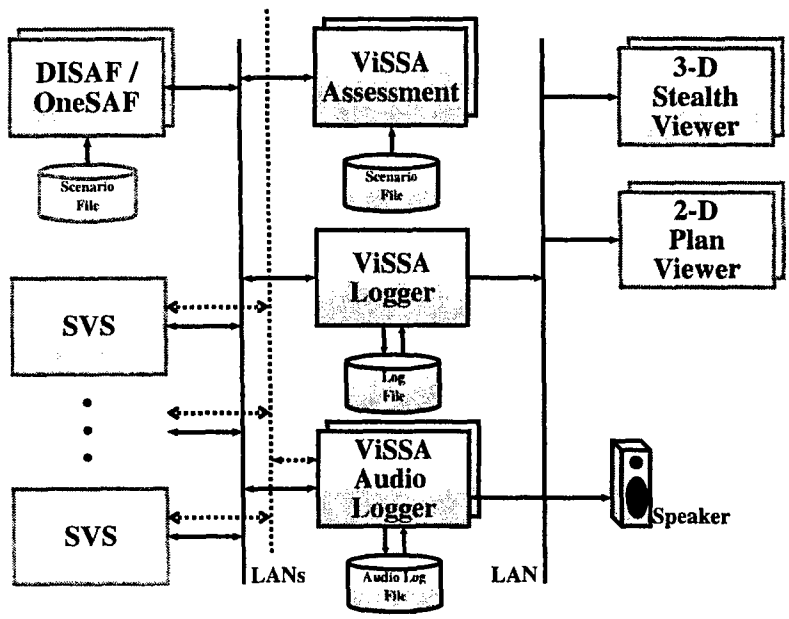

Figure 3. ViSSA environment diagram.

ViSSA Assessment. The Assessment module is used during two distinct periods. First, it is used in conjunction with the Assessment Exercise Development Methodology, well before the actual exercise, to create a scenario file. During this time period, the exercise author works with the Battlemaster to create both a OneSAF/DISAF scenario file (containing SAFs, SAF movements and behaviors, routes, overlays, areas, lines, and points) and the Assessment scenario file (containing the unit hierarchy, observations, and E/C/As). The Assessment Exercise Development Methodology also calls for the development of an operations order (OPORD) and other mission briefing materials. In support of this use, the Assessment module's design includes dialog boxes to visualize the unit hierarchy and the overlay graphics that were created by OneSAF/DISAF – as well as a Microsoft Visual Basic Script (VBScript) editor and error checker.

The Assessment module is also used during the exercise. During this period, the module is designed to be remotely controlled from the Logger module. The design called for the creation of a ViSSA COM Object Model to store details of entities captured via PDU packets (IEEE Std 1278.1a-1998). The module design called for a robust DIS exercise scripting engine to support arbitrary assessment rule execution. As currently used, this feature allows for automating the detection and marking of significant events on an exercise timeline. The power and flexibility of this module allows it to be used for as-yet unknown applications including: new PDUs, arbitrary assessments, adaptive training and assessment, custom data collection, custom data analysis, and custom data reporting (IST-CF-03-01). Moreover, using standard Microsoft COM Automation™ and Microsoft's VBScript language means that anyone who is competent in creating Microsoft Excel™ macros can be effective in creating custom automated solutions. The use of Wizards and GUI screens simplifies rule/script entry for common assessment items.

For situations where an assessment is required for which there are no relevant PDUs, the design includes an Observation feature in which the O/C can manually alert the Assessment module of some specific Soldier behavior that can then be assessed.

ViSSA Logger. The key function of the ViSSA Logger is to capture and record exercise PDU packets. The reasoning behind having a logger is to enable visualization of Soldier actions (on existing 2-D and 3-D visualization components), related to a good or poor decision, during the after action review. Early in the system design phase, the design team learned that there were no free, quality PDU loggers available. The OTB Logger, which was originally developed for ModSAF, was unstable in the OTB environment (related to compression software and an updated entity-state PDU). The MaK Logger, which was in use at the SBL, was expensive and only ran on Silicon Graphics (SGI) workstations (which were being phased out).

Users requested that the Logger be user-friendly and support features such as a graphical timeline, graphical significant event timeline markers, pause, slow/fast forward motion, slow/fast reverse motion, and looping. During the AAR, the Logger allows the trainer to quickly focus on the significant events. Also, the Logger provides the trainer with Socratic questions about the Soldier's actions to focus attention on poor, good, and excellent skills.

ViSSA Audio Logger. During a knowledge acquisition trip to the SBL the design team was advised that it was critical to capture and replay synchronous audio. With this key feedback, the software development team investigated the audio system installed in the SBL – the ASTi DACS system. They determined that the design should include a software module to capture, store, and playback the audio.

The design of the Audio Logger specified playback over the ViSSA computer's speaker before and during the exercise as well as playback over the ViSSA computer's speaker and the DACS system after the exercise. A decision was made to have the Audio Logger be remotely controlled from the ViSSA Logger – minimizing the burden placed on the observer/controller.

System Implementation

Implementing a system of ViSSA's complexity, under the tight budget constraints of an SBIR program, was only possible by using a wide variety of support tools. ScenPro chose to implement ViSSA using Microsoft technology. The software was written in Microsoft Visual Basic 6. The system operates on Windows 2000 and XP platforms.

Each of the three ViSSA modules use WinSock 2.0 to capture and transmit PDU packets over the local area network (LAN).

The Audio Logger uses DirectSound (part of DirectX 8a) to play the DACS radio communications out on the computer's speakers.

The system is capable of exporting all logged PDU packets from an exercise to Microsoft Access™ 2000 using Active Data Objects (ADO) 2.6. The system can also export exercise statistics to a Microsoft Excel 2000 file using COM Automation.

Using Microsoft Scripting Engine 5.6 and Script Control 1.0, the Assessment module implements its own Object Model, which can then be operated on by a scripting engine. The system is currently set to use VBScript, although the system can easily be changed to support other scripting languages such as Java and Perl. Additionally, exercise developers can put VBScript into the E/C/A rules to use COM Automation (Stearns, 1998). The ViSSA Object Model is shown in Figure 4.

Various graphics objects, such as timeline markers and icons were created using Microsoft Paint and Microsoft Imagedit.

During software development, Microsoft Visual Source Safe was used for backup and configuration management of source and object files.

Microsoft's Package and Deployment Wizard was used to create the installation package.

The ViSSA system is designed to work with any Compact Terrain (v7 – little endian) terrain file. The majority of development and testing was done using the McKenna MOUT terrain.

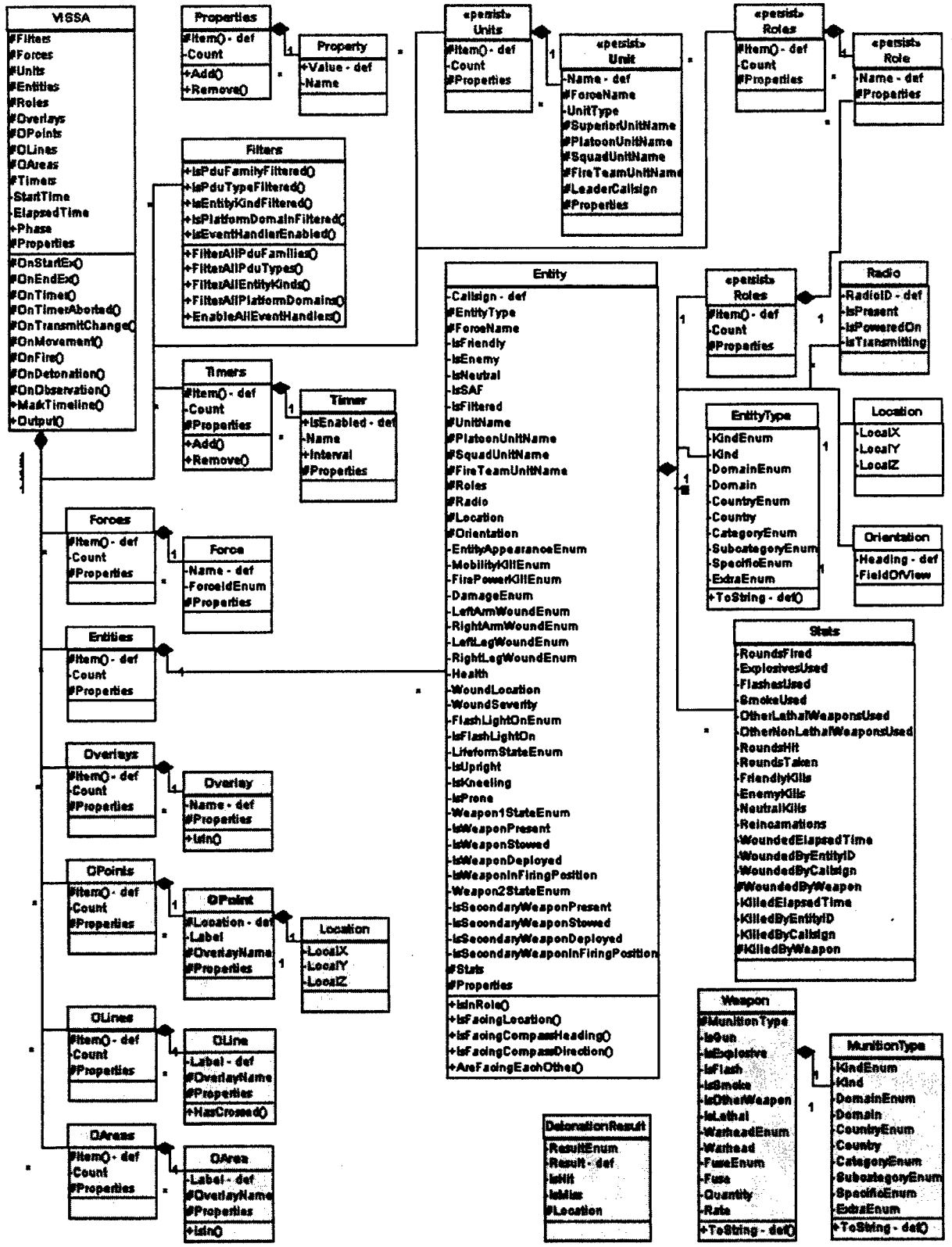

Figure 4. ViSSA object model.

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The Virtual Soldier Skills Assessment System

The results of this SBIR research and development effort are an operational prototype software system (ViSSA), a structured methodology for developing assessment exercises, a network architecture for integrating ViSSA into the Ft. Benning Soldier Battle Lab and other VEs, and a concept of operations for using ViSSA to assess cognitive decision-making skills.

ViSSA System Components

The ViSSA System is composed of three software modules: ViSSA Assessment, ViSSA Logger, and ViSSA Audio Logger (*Figure 5*). The following sections describe the key features and use of these modules.

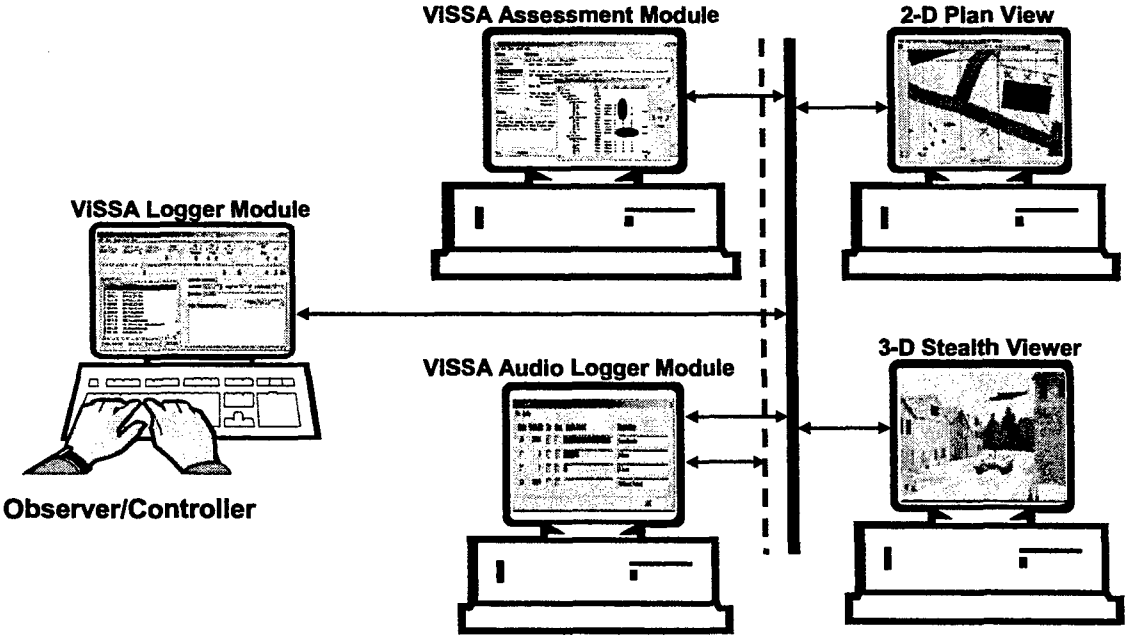

Figure 5. ViSSA system component overview.

ViSSA Assessment module. The BattleMaster uses the ViSSA Assessment module to create the Event/Condition/Action rules that allow the O/C to monitor and assess Soldier performance. The ViSSA Assessment module is a powerful tool in the hands of a skilled BattleMaster. In addition to being able to define arbitrary E/C/A rules using VBScript and the ViSSA Object Model, the user interface provides templates to insert pre-defined assessment rules that selectively monitor and capture specific events during the exercise for real-time analysis.

ViSSA operates by monitoring the PDU traffic being broadcast (by SVSs and SAF programs) during a virtual environment exercise. Using only this PDU traffic, ViSSA creates an internal model (Object Model) of the virtual environment including each entity's location, orientation, posture, equipment, and health. Each time an entity moves, fires, changes posture, makes radio contact, etc., their simulation sends out a PDU message which is received by

Assessment. The Assessment module, in turn, raises an event that can be used to evaluate a simple VBScript rule.

In addition to the information available in the PDUs, ViSSA also supports the notion of a "Phase" of the mission, an arbitrary number of timers, geo-reference points, and user defined variables. Similarly, ViSSA supports the ability for the O/C to indicate a Soldier behavior that is not detectable via PDUs such as a hand gesture or the content of a radio message. These "observations" are specified when the scenario is being created. During the exercise, the O/C, who is sitting at the Logger, can make an "observation." This causes a special (ViSSA-only) PDU to be sent from the Logger to Assessment, where it can launch an E/C/A rule.

Tables 1, 2, and 3 below show the Events, Conditions, and Actions available in the ViSSA Assessment module.

Table 1.

Assessment's Events

Event Name	**Event Description**
OnStartEx	Raised by the Logger when the O/C clicks the "Record" button indicating the start of the exercise
OnEndEx	Raised by the Logger when the O/C clicks the "Stop Record" indicating the end of the exercise
OnTimer	Raised by Assessment when a VBScript-defined timer goes off
OnTimerAbort	Raised by Assessment when OnEndEx is received. This can be used to process timers that had not completed by the end of the exercise.
OnMovement	Raised by SVSs and OneSAF/DISAF programs (via the Entity State PDU) when entities move or otherwise change their state
OnFire	Raised by SVSs and OneSAF/DISAF programs (via the Fire PDU) when entities fire their weapons (including grenades, etc.)
OnDetonation	Raised by SVSs and OneSAF/DISAF programs (via the Detonation PDU) when weapons hit or explode
OnTransmitChange	Raised by Audio Logger when it detects a Soldier toggling their radio (between Standby and Transmit)
OnObservation	Raised by Logger when O/C clicks an observation

Table 2.

Assessment's Conditions

Conditions
Primarily based upon the VBScript IF statement
Main sources of data are the parameters of the Event and the ViSSA Object Model values
Can use the Properties feature to store data for future comparison (such as starting time, starting location, starting health, and starting orientation)
Can use system-level variables: Phase, Start Time, and Elapsed Time

Table 3.

Assessment's Actions

Actions
Change Phase
Store Value in a Property (including a time, a location, a callsign, an arbitrary object, an arbitrary collection of objects, etc.)
Start/End/Reset a Timer
Mark Timeline with a Good or Poor Significant Event or a Comment

Using these tools, E/C/A rules can be developed to assess small unit leader cognitive decision-making skills. Some of the different aspects of the decision-making process that can be assessed using this technology include:

- Route Selection
- Distance Off Route
- Movement into and out of Inclusion/Exclusion Zones
- Use of Cover and Concealment
- Effective Use of Communications (based on ViSSA-only PDU from the Audio Logger indicating a particular Soldier used the radio)
- Use of Environmental Cues
- Situational Awareness (reacting properly to cues)
- Response to threat
- Reaction/Response Times
- Team Control
- Effective Use of Individuals
- Safety and Security
- Weapon accuracy
- Kills (Enemy, Neutral, Civilian, Friendly)
- Meeting Deadlines
- Performance

Leader decision-making skills can also be monitored through the actions of his/her team (assuming the team is following the direction of the leader). ViSSA includes a feature to assign roles to each Soldier. E/C/A rules can be authored to monitor activity by role. For example, team members with the role of rifleman should be the first to enter areas and buildings while the fire team leader should be responsible for communications to the squad leader. Additional decisions that can be inferred about teams include:

- Splitting/joining teams
- Flanking/encircling actions
- Exhibiting a defensive posture

As a more detailed example, the following rules can be created regarding decision-making skills associated with a room clearing exercise:

- Check that the building was cleared
- Check that at least two Soldiers entered each room in the building
- Check that the other fire team maintained a perimeter around the building - defending the fire team inside the building
- Check that the building search begins within XXX seconds of the start of the Phase
- Check that all rooms in the building are searched within XXX seconds
- Check that a Soldier "paints" each wall in each room (by monitoring their orientation)
- Check that Soldiers stay in each room for at least XXX seconds
- Check that a member of the squad radios the commander within XXX seconds after the search is completed
- Check that after one Soldier enters a room, a second enters the room within XXX seconds

The ViSSA Assessment module has been developed to quickly select basic Event Condition/Action rule templates or create E/C/A rules written in VBScript. The ViSSA Assessment module detects the Events as Soldier movement and behavior PDUs are transferred over the simulation network via DIS/HLA. For each type of Event, such as weapon fire or movement, there is an event handler listed on the left side of the Assessment module screen, as seen in Figure 6. The VBScript code that describes the Condition and the resulting Action is entered into the corresponding event handler field. When an Event occurs, the code is then run to see if the conditions are met and which Action should follow. An example is a Friendly Fire rule (Figure 6). The Event would be the firing of a weapon (which is handled by the OnFire) event handler.

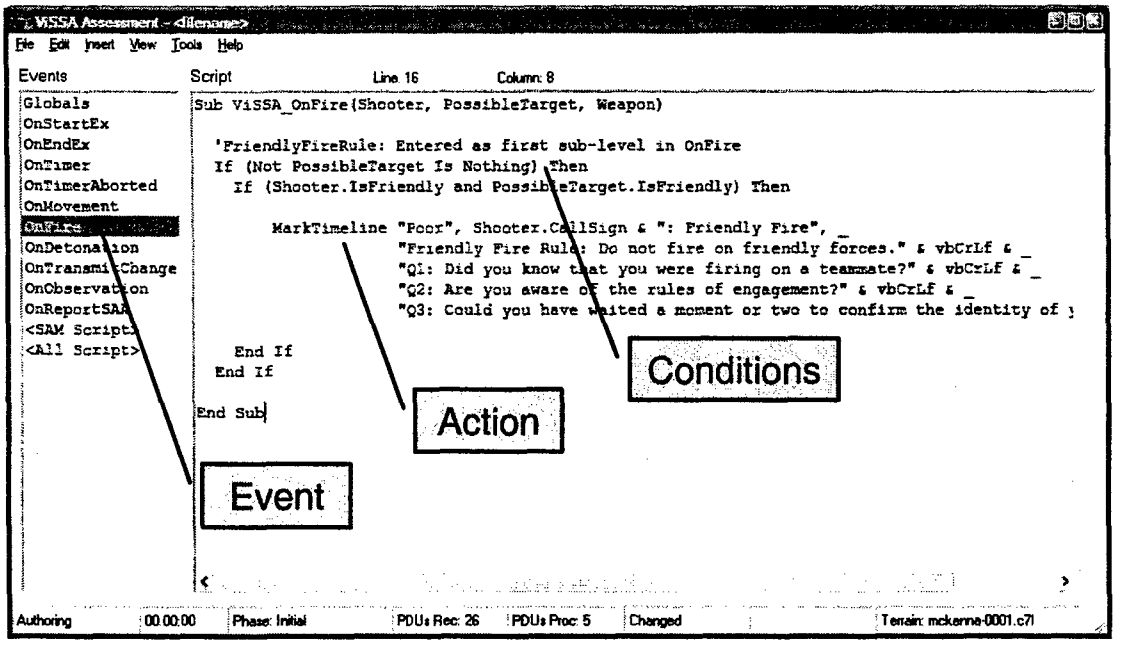

Figure 6. The ViSSA Assessment module user interface.

The VB Script is inserted into the OnFire event handler to check the force of the shooter and target. In this example, if both shooter and target are Blue Forces (BLUFOR), the resulting Action is a "Poor" mark on the exercise timeline of the logger.

In the case of the E/C/A rule templates (Figure 7), the code is automatically inserted into the proper event handlers. E/C/A rules provide the O/C with a cost-effective technology to specify which Soldier movements and behaviors demonstrate mastery of the predetermined training and learning objectives. In addition, Soldier decisions, actions, and behaviors of grave concern such as fratricide can be preprogrammed for immediate system alert to the O/C.

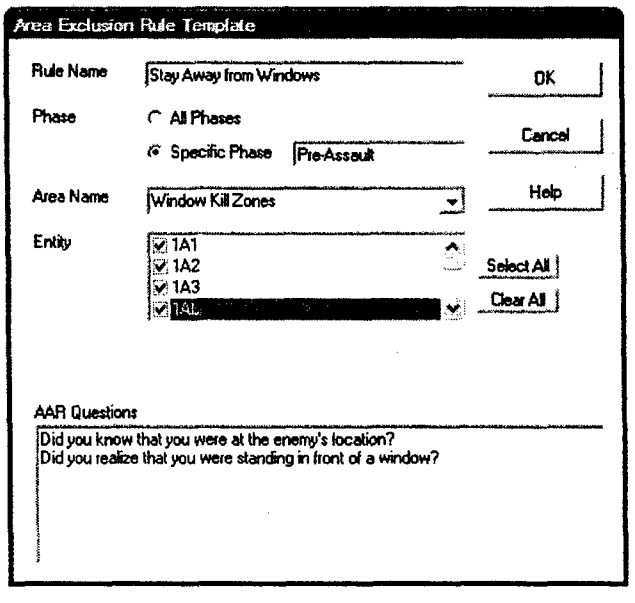

Figure 7. Rule template dialog box (area exclusion rule).

ViSSA Logger. The ViSSA Logger acts as the run-time user interface that captures and stores all PDUs from the virtual exercise and displays a time-stamped summary of real-time events (assessments of significant events, fires, hits, kills, etc). The exercise time-line allows the BattleMaster to make observations, manually add significant event markers, or monitor automated significant event markers received and recorded from the ViSSA Assessment Module using pre-defined assessment criteria.

An image of the Logger's user interface is shown in Figure 8. The top includes VCR-like controls to record and playback the exercise. Along the timeline, green, up-arrows indicate good decision-making, red, down-arrows indicate poor decision-making (as defined by the exercise developer), and grey, up-arrows are comments. During the exercise, the O/C can manually enter significant events. The lower part of the Logger shows detailed information about each significant event.

Following the virtual exercise, the ViSSA Logger is an effective AAR tool providing a full playback capability. In particular, the Logger will playback all captured PDUs over the LAN. Playing back these PDUs allows the exercise to be re-lived via 2-D and 3-D viewing applications such as OneSAF, DISAF, and stealth viewers. This allows the BattleMaster, O/C, or trainer to quickly focus on key decisions and events that occurred during the virtual exercise. When there is limited time for an AAR, the trainer can quickly illustrate the tactical situation that should have elicited a response from the trainee, or selectively focus on positive or negative outcomes of decision-making by the trainee (e.g., show how the squad took direct fire when the leader trainee commanded crossing an open area without cover). Other features include playing forward/backward, looping, playing at a faster speed and in slow motion.

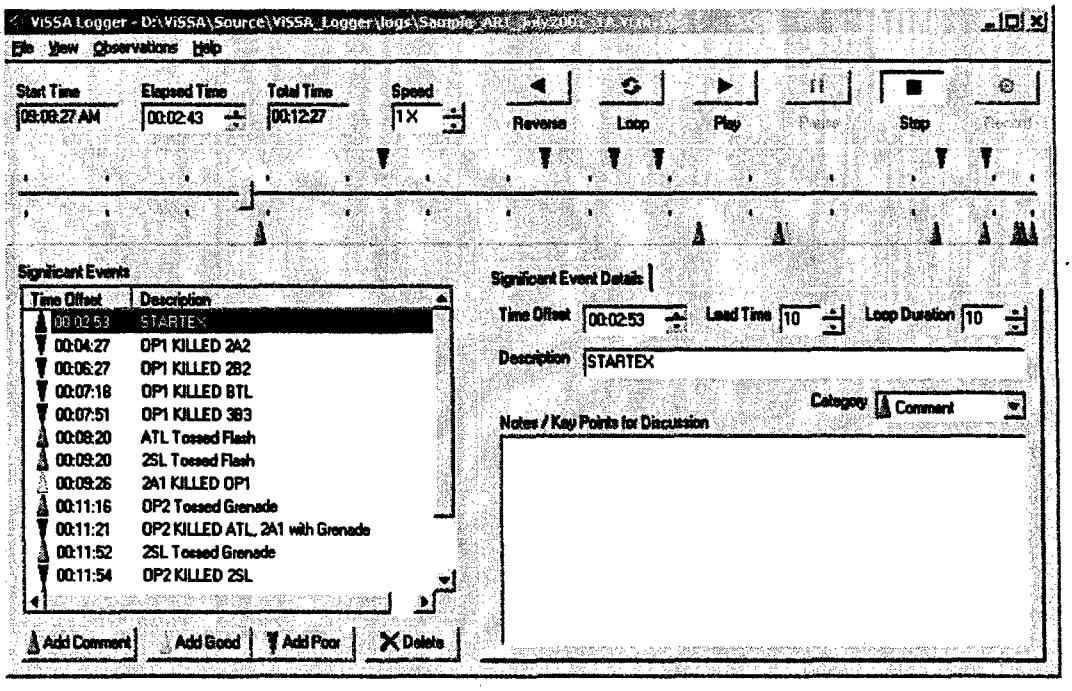

Figure 8. ViSSA Logger graphical user interface.

The Logger provides a number of administrative, analysis, and reporting tools to support the BattleMaster and O/C during the exercise and to support the Trainer and Researcher after the exercise. During the exercise, the Events dialog box (Figure 9) displays a brief (or verbose) summary of all the key events that occurred during the exercise.

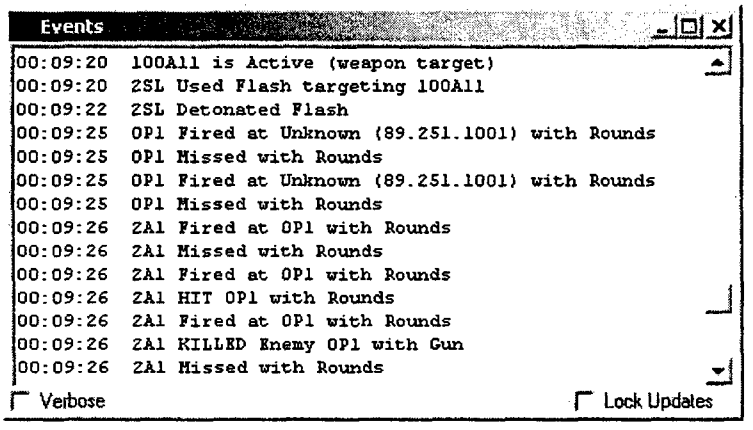

Figure 9. Logger events dialog box.

During the exercise, the Logger provides a Mission Status dialog box (Figure 10) showing high level statistics about each Soldier. These statistics are organized by callsign and include their health and details of their weapons use (fires, hits, kills, etc.).

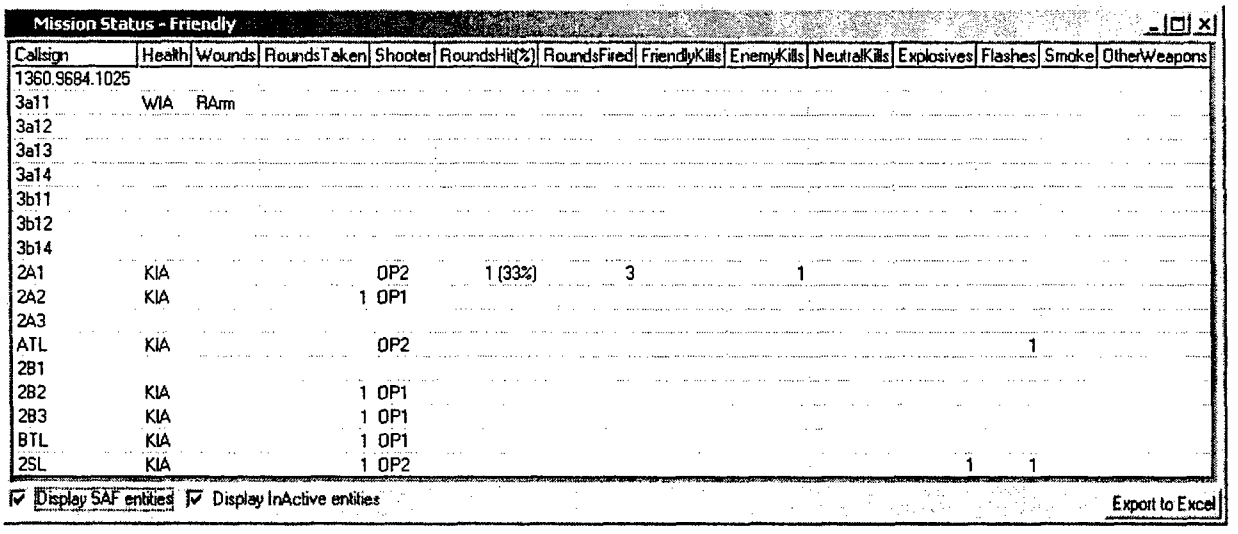

Figure 10. Logger mission status dialog box.

The PDU Statistics dialog box (Figure 11) is provided by the Logger to support the BattleMaster and O/C. It displays a brief summary of the number of PDUs of different types that have been received by the Logger. This is useful to ensure that all of the components of the Soldier Battle Laboratory are operating properly.

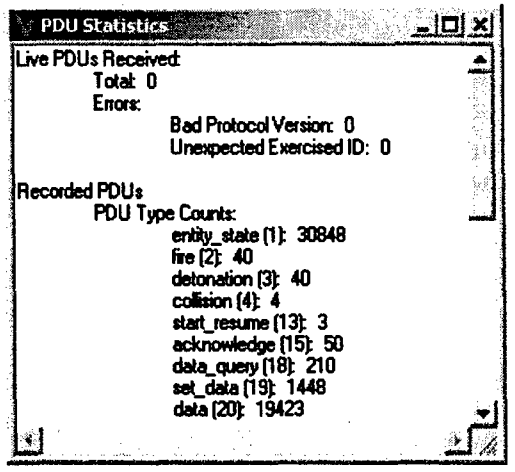

Figure 11. Logger PDU statistics dialog box.

The Logger allows the user to export data in three ways:

- The Event Summary data (Figure 9) can be exported to a simple text file
- The Mission Status data (Figure 10) can be exported to MS Excel (Figure 12)
- The PDU data can be exported to MS Access database (Figure 13).

Microsoft Excel - Book1

File Edit View Insert Format Tools Data Window Help

Arial 10

=EntityID

	A	B	C	D	E	F	G	H	I	J	K
1	EntityID	ForceID	Force	UnitName	Marking	EntityType	EntityTypeShort	isSAF	isActive	HealthID	Health
2	1360.9684.1025	1	Friendly			3.1.225.1.32.1.0	Lifeform	FALSE	TRUE	0	OK
3	1499.9565.1016	1	Friendly		3a11	3.1.225.1.102.1.0	Lifeform	FALSE	TRUE	1	WIA
4	1499.9565.1007	1	Friendly		3a12	3.1.225.1.73.1.0	Lifeform	FALSE	TRUE	0	OK
5	1499.9565.1023	1	Friendly		3a13	3.1.225.1.32.1.0	Lifeform	FALSE	TRUE	0	OK
6	1499.9565.1002	1	Friendly		3a14	3.1.225.1.116.1.0	Lifeform	FALSE	TRUE	0	OK
7	1360.9684.1019	1	Friendly		3b11	3.1.225.1.32.1.0	Lifeform	FALSE	TRUE	0	OK
8	1360.9684.1009	1	Friendly		3b12	3.1.225.1.73.1.0	Lifeform	FALSE	TRUE	0	OK
9	1360.9684.1003	1	Friendly		3b14	3.1.225.1.116.1.0	Lifeform	FALSE	TRUE	0	OK
10	89.153.1001	1	Friendly	2S Alpha Team	2A1	3.1.225.1.41.1.0	Lifeform	FALSE	TRUE	2	KIA
11	89.154.1001	1	Friendly	2S Alpha Team	2A2	3.1.225.1.41.1.0	Lifeform	FALSE	TRUE	2	KIA
12	89.155.1001	1	Friendly	2S Alpha Team	2A3	3.1.225.1.41.1.0	Lifeform	FALSE	TRUE	0	OK
13	89.152.1001	1	Friendly	2S Alpha Team	ATL	3.1.225.1.41.1.0	Lifeform	FALSE	TRUE	2	KIA
14	89.157.1001	1	Friendly	2S Bravo Team	2B1	3.1.225.1.41.1.0	Lifeform	FALSE	TRUE	0	OK
15	89.158.1001	1	Friendly	2S Bravo Team	2B2	3.1.225.1.41.1.0	Lifeform	FALSE	TRUE	2	KIA
16	89.159.1001	1	Friendly	2S Bravo Team	2B3	3.1.225.1.41.1.0	Lifeform	FALSE	TRUE	2	KIA
17	89.156.1001	1	Friendly	2S Bravo Team	BTL	3.1.225.1.41.1.0	Lifeform	FALSE	TRUE	2	KIA
18	89.151.1001	1	Friendly	2nd Squad	2SL	3.1.225.1.41.1.0	Lifeform	FALSE	TRUE	2	KIA

Friendly / Enemy / Neutral /

Ready

Figure 12. Logger statistics data exported to MS Excel.

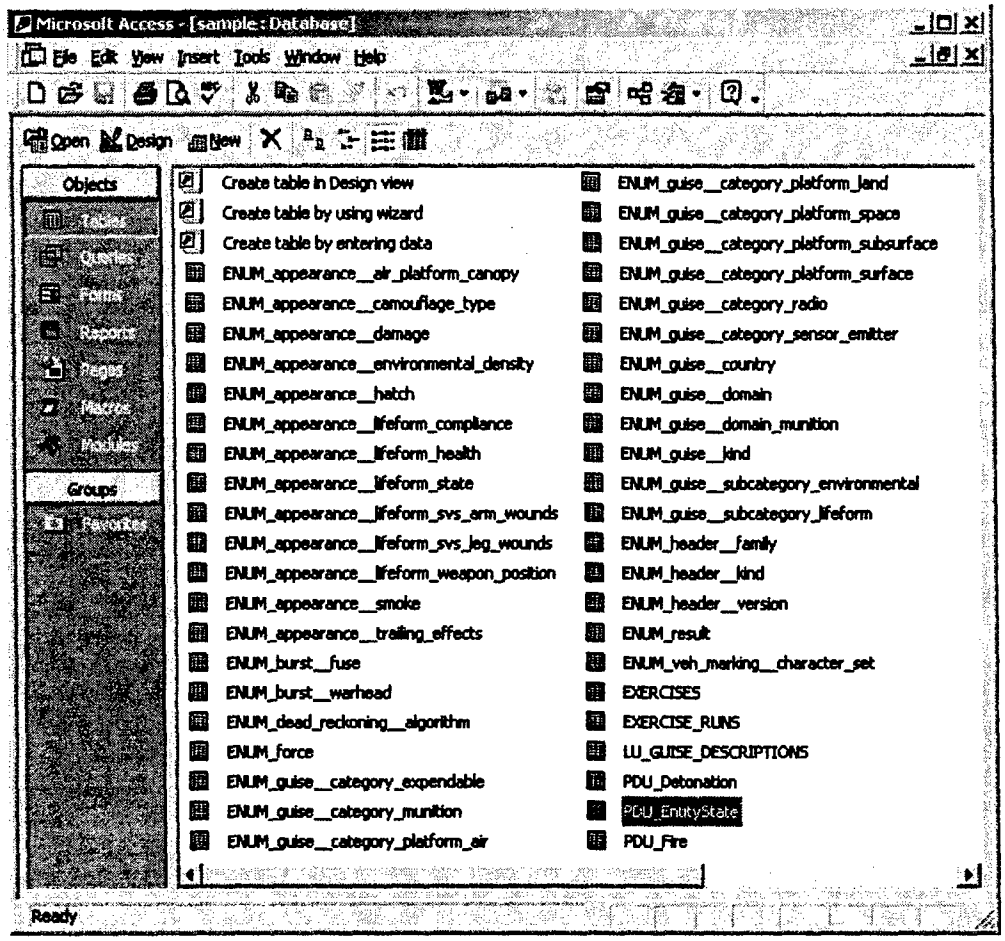

Figure 13. Logger PDU data exported to MS Access.

The MS Access database that is created by the Logger includes all PDU data captured during the exercise as well as a large number of enumeration (ENUM) tables used to translate the numeric tags to English descriptions. The database is pre-loaded with 19 common queries (Figure 14) that can extract information such as who shot whom.

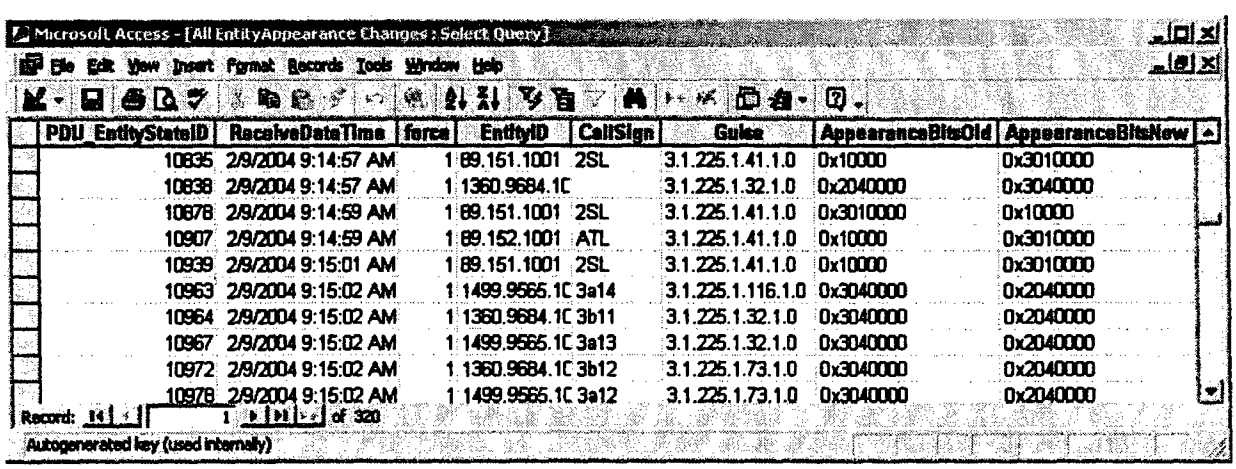

Figure 14. Example MS Access query: Show all entity appearance changes.

ViSSA Audio Logger. The ViSSA Audio Logger captures and stores audio PDUs for synchronized audio playback in conjunction with the ViSSA Logger, as shown in Figure 15. It allows for quick identification of who is speaking on the radio, muting, and isolation of specific radio channels by the BattleMaster. Additionally, it forwards communication-related data to the ViSSA Assessment Module. This allows exercise developers to create E/C/A rules to evaluate Soldier decision-making from the standpoint of communications (e.g., did the team leader provide a Situation Report (SITREP) to the squad leader shortly after the sniper began firing).

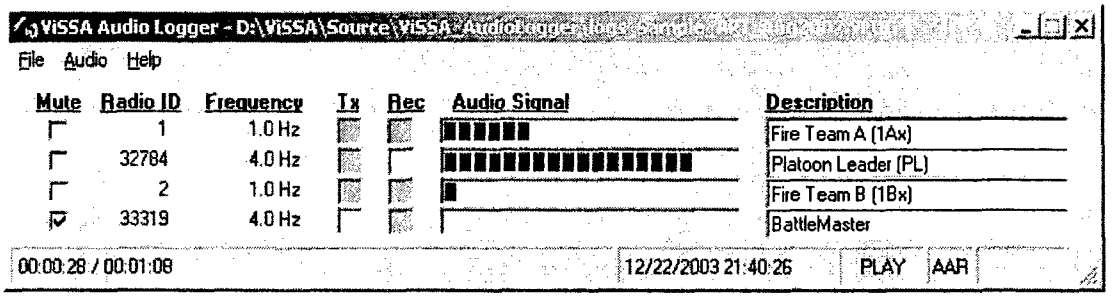

Figure 15. ViSSA Audio Logger graphical user interface.

The ViSSA Audio Logger display is expandable (vertically) based on the number of radios used during the exercise. It provides a convenient way to "see" who is talking during an exercise and provides the ability to add meaningful text descriptions to each radio channel.

Assessment Exercise Development Methodology

Scenario-based training provides a dynamic environment for Soldiers to learn and demonstrate cognitive decision-making skills. MOUT is clearly the most demanding of the environments Soldiers must operate in (Gorman, 2000). The VE shows promise in providing Soldiers the opportunity to prepare for MOUT situations in a safe and supportive training environment. Scenario experiences provide Soldiers with a knowledge base to quickly draw from when instantaneous cognition and decisions are necessary.

The evolution of the VE now provides Soldiers with a broad selection of simulated environments for training and assessment at a single location. It is however necessary to structure the exercise so that it resembles actual or plausible challenges for it to be of value for Soldiers and their organization. The scenario development process must also be structured in a way to ensure that it supports current and evolving doctrine in order to maintain exercise relevance and expansion of the VE as a viable training and assessment option.

Soldiers can gain knowledge and skills in several ways including classroom, tabletop exercises, field exercises, and deployment experience. Once small unit team leaders have a minimum level of skill, they can be assessed using ViSSA.

At the highest level, the exercise development methodology is composed of five phases (Table 4). The five phases are adaptable to VE-based assessment either pre-exercise, during the exercise, or post-exercise. The phases are detailed in the table below:

Table 4.

Five Phases of Assessment Adapted to the VE

Phase	Purpose	Time Frame
Assessment Exercise Development	Identification of the assessment participants, needs analysis, prerequisites, equipment, safety issues, and facility selection. Design of exercise including objectives, entities, obstacles, and decision-making skills to assess. Selection of terrain. Selection of key geographical locations. Development of briefing materials.	**Well-prior to the Exercise**
VE Familiarization	Introduce Soldier to virtual environment	**Prior to the Exercise**
Pre-Mission Briefing	Presentation of the training/mission objectives	**Immediately Prior to the Exercise**
Assessment	Provide trainee the opportunity to exhibit the desired knowledge or skill during a real-world scenario in the Virtual Environment	**During the Exercise**
Evaluation	Conduct After Action Review representing trainee strengths and weaknesses observed during demonstration of skills	**Post-Exercise**

As part of this SBIR effort, ScenPro developed a methodology for creating assessment exercises. The ViSSA Assessment Exercise Development Methodology (AEDM) is a 12 step procedure for creating a VE-based, decision-making assessment scenario.

The Assessment Exercise Development Methodology steps are:

1. Identify Soldier skill(s) being assessed
2. Review source of Soldier knowledge
    a. Training Material
    b. Documentation
3. Determine Scenario Complexity Level
    a. Introductory
    b. Basic
    c. Intermediate
    d. Advanced

4. Create a scenario, with believable context, to stress one or more of the skills. Document using the 5-paragraph OPORD format.
5. Determine expected Soldier actions within the scenario (based upon Scenario Complexity Level)
6. Indicate key decision points within the scenario relative to the skills being assessed
7. Identify observable actions that can be used to quantify the Soldier's application of the skill being assessed
8. Determine, in conjunction with the O/C, how to capture each action
    a. Directly Observable with PDUs
        1. Motion of Soldier or SAF into or out of Inclusion or Exclusion Area
        2. Motion of Soldier or SAF across Phase Line
        3. Fires by Soldier or SAF
        4. Wound/Kill of Soldier, Teammate, or SAF
        5. Radio Transmission by Soldier or O/C
        6. Exercise Time (minutes since the start of the exercise)
    b. Computable
        1. Reaction Time (time between one action and another)
        2. Facing (when two entities are facing each other)
        3. Distance (between Soldier and target or rally point)
    c. Inferable
        1. Team Behavior (over march, covering fire, coordinated assault)
        2. Complex Routes (to avoid kill zones)
        3. Sophisticated use of Weapons (smoke and flash-bangs)
    d. Observations by Observer/Controller
        1. Hand gestures
        2. Content of radio communications
9. Create a new scenario in DISAF/OneSAF
    a. Lay down forces (Friendly, Neutral, Enemy)
    b. Create overlay graphics and enter required points, lines, areas, and SAF triggers – annotate each
10. Create new ViSSA scenario using Assessment module
    a. Specify which forces are SAF and which should be Assessed
    b. Specify specific Observations the O/C can make during exercise
    c. For each E/C/A, include Socratic questions to support AAR
11. Create Mission Briefing material to give to the Soldier prior to entering the SVS
12. Create instructions for the O/C

As shown in Step 3 above, the AEDM includes the concept of Scenario Complexity Levels (SCL) to establish metrics for VE exercises. The SCL provides a structure for trainers to design and execute scenario missions that meet the needs of the individual Soldier.

> *Scenario Complexity Level 1: Introductory.* Introductory level scenarios allow trainees to get comfortable with the VE technology in a low stress environment. Trainees will have to manage minimal skills to accomplish the terminal learning objective (TLO). See example Level 1 scenario in Appendix B.

Scenario Complexity Level 2: Basic Skills. Level 2 scenarios provide an opportunity for the trainee to manage a combination of skills and is suited for trainees without extensive experience or training in the primary TLO. See example Level 2 scenario in Appendix C.

Scenario Complexity Level 3: Intermediate Skills. Level 3 scenarios provide an opportunity to apply experience while managing several skill sets. Level 3 scenarios are best suited for operationally experienced trainees. See example Level 3 scenario in Appendix D.

Scenario Complexity Level 4: Advanced Skills. Level 4 scenarios provide an opportunity for the trainee to apply experience and skills in a dynamic, demanding environment. The trainee will be required to manage multiple skills to meet the TLO. Level 4 scenarios are best suited for trainees with both operational and VE experience. See example Level 4 scenario in Appendix E.

As described in Step 9 above, the BattleMaster uses OneSAF/DISAF to pre-define the semi-automated forces and other features of the scenario to establish the appropriate SCL. In particular, a scenario may include the following items to increase complexity:

- Opposing Forces
- External distractions to BLUFOR activities
- Time constraints on BLUFOR activities
- Requirements to manage personnel

Network Architecture

The ViSSA system can be configured in two ways. The first, shown in Figure 3 above, is appropriate for a facility where the exercises occur in the same room as the after-action reviews. The second, shown in Figure 16 below, is appropriate for a facility that has separate exercise and AAR areas and holds back-to-back exercises.

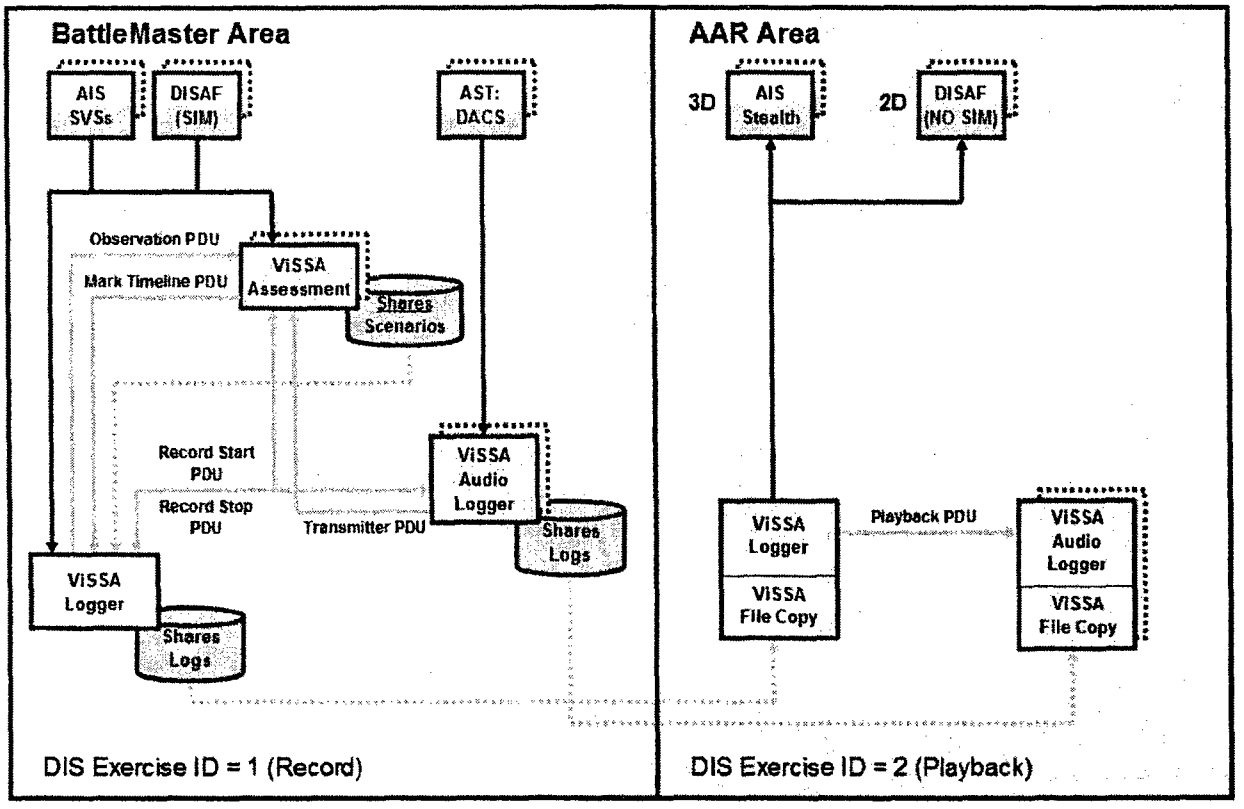

Figure 16. ViSSA system component integration with existing SBL network configuration.

The ViSSA System Concept of Operation

Before the exercise. Prior to an exercise, a trainer or commander will meet with the virtual environment O/C or BattleMaster to develop an exercise scenario that will assess a particular Soldier skill or set of skills (e.g., the effective use of cover and concealment). Following the ViSSA Assessment Exercise Development Methodology, a scenario is created and Event/Condition/Action rules are defined.

Immediately prior to the assessment exercise, Soldiers are given an opportunity to get familiar with the VE and then given a traditional mission brief.

During the exercise. During the exercise, the O/C can monitor the activity of the system and the trainees using the Events and Mission Status displays. The O/C can move freely through the simulated environment in a stealth mode using the 3-D stealth view or can monitor movement using the 2-D plan view display. The O/C can manually mark key decisions or events observed, and monitor the automated capture of key events resulting from predefined O/C criteria. The ViSSA Assessment Module automatically evaluates assessment rules against Soldier performance as the exercise proceeds, looking for significant events and conditions that were defined before the exercise and identified for capture. When the appropriate event/condition(s) are met, the system flags the exercise timeline located on the ViSSA Logger Module interface with a mark indicating a Good or Poor decision.

After the exercise. Once the exercise is completed, the BattleMaster or O/C can immediately begin the AAR. The ViSSA Logger and ViSSA Audio Logger are used to playback logged PDU data with synchronized radio communications from the exercise. The playback can be watched across a DIS network using the OTB 2-D Plan Viewer and various 3-D stealth viewers. The ViSSA Logger displays an exercise timeline with color-coded markings showing each of the significant events from StartEx to EndEx that were manually identified by the O/C or triggered automatically in accordance with the Event/ Condition/ Action rules. Selecting a mark on the timeline initiates playback of the exercise leading up to the significant event. The VCR-like controls support pause, fast/slow, reverse, and looping. This allows the Battlemaster, O/C, or trainer to quickly focus AAR activities on key decision points during the mission. The O/C also has access to the Event and Mission Status displays. The AAR discussions are facilitated by a set of Socratic questions about the event.

ViSSA Prototype Demonstrations

During the development effort, several opportunities were provided for observation, experimentation, and evaluation at the SBL facility. These opportunities included participation in Army Research Institute (ARI) experiments, technology demonstrations, and ViSSA system testing. These opportunities are described in more detail below:

Mission rehearsal experiment (July 2002). This research examined the use of virtual environments as a viable dismounted infantry mission rehearsal tool (see Pleban & Salvetti, 2003). A prototype ViSSA system was successfully used to augment the AARs provided at the SBL. Numerous improvements were made to the design of the system based upon this experience.

Science and Technology Objective (STO) Culminating event (September 2002). The ARI Simulator Systems Research Unit and the University of Central Florida Institute for Simulation and Training conducted technology demonstrations at the SBL using DIVAARS. The event represented the culmination of a 4-year STO that was established to address selected technological and training issues related to high fidelity dismounted Soldier simulation. This event provided the ViSSA development team with an opportunity to observe a formal AAR and the types of summary statistics of value and interest to the trainer. A great deal of useful information was learned about AAR tools during this event.

Joint Conflict and Tactical Simulation (JCATS) 4.1 exercise (February 2004). ScenPro was asked to support a large, classified exercise at the Ft. Benning SBL that included all available SVSs and JCATS 4.1. JCATS simulates large groups of Soldiers. The SBL Battlemaster used ViSSA to: compute exercise statistics, record the exercise, and visualize the system configuration and status. Many exercises were held during several weeks at the SBL. The number of entities participating in the exercises varied between 600 and 1900. Feedback from the exercise indicated that ViSSA was highly valued for it ability to display configuration and status information, record and playback PDUs, and to compute statistics in real time.

Methods

Overview

Just prior to the completion of the contractual period, a capability assessment evaluation of the ViSSA system was performed at the Soldier Battle Laboratory in Ft. Benning by the BattleMasters. This evaluation took place in November 2003. The evaluation included a presentation about the system, training, and an assessment exercise. A US Army Soldier participated in the demonstration by entering the VE via an SVS and performing a small task. After the training the Battlemasters completed a pen and paper questionnaire about the capabilities of the system.

Preparation

Successful installation and testing of ViSSA took approximately 4 hours. Following installation a presentation was given to BattleMasters and other interested parties (See Appendix F). During the training the BattleMasters participated in the authoring of the E/C/A rules for the demonstration.

Participants

The participants of the capability assessment evaluation consisted of the three SBL BattleMasters. These BattleMasters were male, with ages ranging from 30 to 55, and had between 1 and 5 years of experience.

Instrument

The capability assessment evaluation questionnaire was designed for this evaluation and contained a total of 30 questions. The first 26 questions had quantitative 5-point Likert scale answers ranging from Strongly Agree to Strongly Disagree. The final 4 questions asked for qualitative comments, feedback, or evaluation. The questions focused on the usefulness of features and functionality provided by various components of the system.

Procedure

Following the training, a capability assessment evaluation was given to the BattleMasters to obtain their feedback regarding the exercise monitoring, AAR analysis and review support, and AAR radio communications playback capabilities. Participants were not given any time limits for completing the questionnaire.

Analysis

After the capability assessment evaluation questionnaires were completed, the answers were analyzed using simple averages. One participant did not answer questions 18-26. Because of the small sample size, results should be viewed with caution.

Results

ViSSA Evaluation at the Soldier Battle Lab

The results (Table 5) showed that BattleMasters agreed or strongly agreed with the usefulness of 95% of features offered by the scenario authoring component. In addition, they agreed or strongly agreed with the usefulness of 100% of features and functionality provided by all other system components. BattleMasters were asked for a list of improvements to the ViSSA user interfaces and information display methods that could greatly improve assessment effectiveness. The recommendations included a drag and drop function to reduce dependence on drop-down menus from the various ViSSA user interfaces, a "sort data by category" option to isolate similar types of information (Kills, Fires, Fratricides) when reviewing exercise summary statistics, and a Select All/DeSelect All feature to define which Soldiers will be assessed by the E/C/A rules. A copy of the capabilities assessment questionnaire, containing the actual number of responses per question, is located in Appendix G.

Table 5.

ViSSA Capability Assessment Evaluation Results

SYSTEM CAPABILITY	FEEDBACK	PERCENTAGE
Scenario Authoring (comprising 7 questions)	Strongly Agree	62%
	Agree	33%
Exercise Monitoring (comprising 4 questions)	Strongly Agree	92%
	Agree	8%
AAR Analysis & Review (comprising 10 questions)	Strongly Agree	100%
AAR Radio Communications (comprising 5 questions)	Strongly Agree	100%

Conclusions and Recommendations

The Virtual Soldier Skills Assessment system is enhancing the U.S. Army's ability to train decision-making skills to dismounted, small unit leaders (platoon, squad, and team) in virtual environments. The ViSSA system is supporting research into virtual environment training, assessment, modeling, and simulation technology at the Soldier Battle Lab in Fort Benning, Georgia. The extensive features and functionality of ViSSA provide comprehensive assessment of Soldier and small unit leader cognitive decision-making skills during training, assessment, and mission rehearsal exercises. Moreover, ViSSA functionality can support research and development efforts including experimentation into future combat systems such as providing remote sensor data using robots and Unmanned Air Vehicles.

ViSSA complements PEOSTRI OTB (versions 1.0 and 2.0), DISAF (versions 8.0 and 9.4) software, and SVS software, providing an efficient, cost effective way to monitor and assess virtual environment training while greatly easing the burden on the Observer/ Controller. It

apply meaningful data output and statistics to the execution of simulated missions in the virtual environment.

The automated data collection and feedback system is capable of accurately assessing small unit leader decision-making skills based on pre-defined criteria encoded as E/C/A rules. It is capable of operating beyond the limitations of the VE by taking advantage of the O/C's eyes and ears and the annotated observations feature. It allows BattleMasters, O/Cs, and trainers to easily orchestrate a effective, multi-media, after-action reviews. Finally, following the virtual assessment exercise and after-action review, the ViSSA system provides optional storage of large quantities of logged data, using an Export Wizard, which produces an MS Access database file containing all PDUs. This allows researchers to use MS Access to view all fields and to produce custom queries or reports for further in-depth analyses.

While the primary perspective of this effort was the assessment of dismounted infantry in general and small unit team leaders in particular, every aspect of the system is expandable to the assessment of any virtual entity including manned and unmanned vehicles including tanks, boats, ships, and aircraft.

Overall, while there were limitations in the evaluation process, the system has received strong support from BattleMasters, Observer/Controllers, and VE researchers.

Impact of ViSSA on After-Action Reviews

The Army has adopted the after-action review process as the primary means of providing feedback after collective training exercises (Darling & Parry, 2000). The effectiveness of an after-action review is dependent upon how well the observer/controller or trainer can visually represent and organize data captured during the exercise to guide interactive discussions and recommendations for performance improvement (Morrison & Meliza, 1999). Dismounted Infantry in a MOUT environment places greater demands on O/Cs due to the rapid pace of action and the obstruction of view because of building structures.

In the virtual environment, the O/C must often play the role of a higher command by monitoring and participating in the radio transmissions during the exercise. The O/C may also be required to perform a variety of exercise control functions including control of the semi-automated forces. These activities compete for the O/C's attention, and interfere with the primary goal of performance evaluation. By allowing the O/C to predefine performance evaluation criteria, the ViSSA system will automatically capture key events related to Soldier performance occurring during the virtual exercise for after-action review. ViSSA automates after-action review preparation through the use of expert system rules to keep trainer requirements to a minimum and avoid distracting trainers from exercise control functions. The need to develop tools and procedures that can improve the quality of training and assessment exercises and timeliness of feedback products for the after-action review in DIS and HLA environments has driven the present research.

The ViSSA system dramatically enhances the AAR capability by providing trainees with immediate video/audio playback of exercise events, and a timeline display depicting significant events that were captured during the exercise. Summary statistics supplement the multi-media displays by calling out killer/victim information, reaction times, and important analytical details buried within the flurry of simulation activity. Together, this information provides a performance baseline for improved Soldier decision-making in the future. In addition, the statistical summaries can be used to support continued research, development, and analysis.

Recommendations

In order to fully assess a Soldier's decision-making skills, it is necessary to go beyond capturing the Soldier's observable actions and understand the important role of verbal communication during mission execution. A logical extension of ViSSA might include analysis of the types and frequency of radio communications to provide valuable information concerning confidence, cognitive decision-making, and leadership skills (Evans & Christ, 2003). Types of communication include requests for information, status reports, and commands.

Extending ViSSA's capability to record and store pertinent data captured during assessment exercises would create a useful corpus of training and assessment related data. Over time, this data could be used to generate statistics about areas where Soldiers perform a skill particularly well or particularly poorly, about prerequisites for specific courses, and the effectiveness of one training approach over another that could improve training in the future. A long term data storage and analysis module could provide this functionality.

The following is a list of possible future enhancements by module:

ViSSA Assessment

- Continue to raise level of abstraction for rules/scripting
    - Expand number of Rule Templates (Wizards)
    - Expand number of raised events
    - Expand object model's objects and the attributes automatically tracked
- Create generic E/C/A Rule Template Wizard that constructs rules based on primitives
- Intervisibility support (automatically calculating when one entity can "see" another)
- Built-in support for aggregating measurements from individual to unit level
- Enhance Area overlay graphics to understand buildings:
    - Automatic comprehension of floors
    - Automatic comprehension of areas within buildings
        - Buildings, floors, rooms
        - Stairs, doors, windows
    - Add ability to automatically understand terrain file MES structures
- Recognize and reason about team formations
- Expand to customize handling of more entity types
    - Armor, Aircraft, Sensors, UAVs, UGV, FCS, etc

- Stealth Viewer support:
    - Define list of stealth viewers to be used during AAR
    - Pre-define list of fixed stealth teleport locations for use during AAR
    - Associate a stealth teleport command with timeline event marker
- Add tool to support creation/visualization of Phases and Phase Transitions
- Ability to Import/Export VBScript
- Expand to allow for the processing of new, currently undefined PDU messages
- Replace Microsoft WinSock Control so that all apps can be run on one computer
- Addition of numeric scores associated with Good/Poor Decision Making
- Infer Soldier's ability to have heard an environmental sound
- Order SAF into action (inside OneSAF and DISAF)

ViSSA Logger

- Expand statistics collected and displayed
    - Based on feedback
    - Sub-Total statistics at unit levels
- Allow user to customize Mission Summary columns displayed (subset of options)
- Allow user to customize Statistics exported to MS-Excel (subset of options)
- Allow user to customize Messages displayed (verbosity level and subset of options)
- Import/Export of DISAF/OTB logger files
- Create library of sample MS Access reports based on PDU export to MS Access
- Stealth Viewer support:
    - Remote control of Stealth Viewer during AAR
    - Associate a stealth teleport command with a timeline event marker
        - Teleport to fixed location
        - Teleport to an entities' view
- Dynamically change the timescale
- Tool to recover crashed log files
- Replace Microsoft WinSock Control so that all apps can be run on one computer

ViSSA Audio Logger

- Add speech recognition
- Replace Microsoft WinSock Control so that all apps can be run on one computer

Multi-Exercise Support

- Support library of ViSSA Scenarios (cataloging)
- Support database of Exercise Results (searching/analysis/reporting)

Other

- Add small, DIS-aware, packet-sniffing utility

Contact Information

If you are interested in acquiring a copy of ViSSA, please contact Michael Gately of ScenPro at (972) 437-5001.

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Appendix A

Acronym List

AAR	After-Action Review
AEDM	Assessment Exercise Development Methodology
ARI	Army Research Institute
ASTi	Advanced Simulation Technology, inc.
BLUFOR	Blue Forces
CGF	Computer Generated Forces
DACS	Digital Audio Communications System
DIS	Distributed Interactive Simulation
DISAF	Dismounted Infantry Semi-Automated Forces
DIVAARS	Dismounted Infantry Virtual After Action Review System
ENUM	Enumeration
HLA	High Level Architecture
IST	Institute for Simulation and Training
JCATS	Joint Conflict and Tactical Simulation
LAN	Local Area Network
ModSAF	Modular Semi-Automated Forces
MOUT	Military Operations in Urban Terrain
O/C	Observer/Controller
OneSAF	One Semi-Automated Forces
OOS	OneSAF Objective System
OPFOR	Opposing Forces
OPORD	Operations Order
OTB	OneSAF Testbed Baseline
PEOSTRI	Program Executive Office of Simulation, Training, and Instrumentation
PDU	Protocol Data Unit
SAF	Semi-Automated Forces
SBIR	Small Business Innovative Research
SBL	Soldier Battle Lab
SCL	Scenario Complexity Level
SEP	Scenario-based Engineering Process
SGI	Silicon Graphics, Inc.
SITREP	Situation Report
SME	Subject Matter Expert
STO	Science and Technology Objective
SVS	Soldier Visualization Station
TLO	Terminal Learning Objective
TTP	Tactics, Techniques, and Procedures
VBScript	Visual Basic Script
VE	Virtual Environment
ViSSA	Virtual Soldier Skills Assessment

Level 1 Training Mission

Task Patrol[1]

Conditions

The Fire Team will perform a scheduled patrol as part of a Peace Keeping Coalition. The Fire Team is operating separately from its squad and platoon.

Task Standards

The Fire Team must patrol a geographically defined sector of urban terrain. The squad must maintain security throughout the mission. Casualties are not acceptable.

Mission Features

- Requires the management of multiple personnel

Operations Order

Situation

Potential aggressors are categorized as armed and unorganized criminal elements whose objectives are to loot, destroy property, and terrorize local populace.

Fire Team Delta will act separately from the squad and platoon and not possess any support. The squad will be dismounted.

Mission

Fire Team Delta will conduct a scheduled routine patrol of a designated geographical area.

[1] U.S. Department of the Army (September 1994). *Mission training plan for the infantry rifle platoon and squad* (ARTEP 7-8-MTP). Washington, DC: Author.

Execution

Fire Team Delta will act with good judgment in all facets of day-to-day operations. *The Rules-of-Engagement (ROE)* are restrictive. Soldiers will use directed force only when necessary to defend themselves or another from serious bodily injury or death. No unwarranted damage to the structures or disruption of the local services will be tolerated.

Fire Team Delta will patrol the southeast sector of the simulated city. The Team will ensure that the thoroughfares are clear of non-coalition forces and that the coalition-mandated curfew is enforced. The Fire Team will begin operations at building C6 and patrol once around each of the buildings southeast of Rumble Road and North Highway. Fire Team Delta will conclude operations by returning to building C6 and providing a SITREP to the Platoon Leader.

The Team will effectively maintain 360-degree security throughout the mission.

(The Team Leader will stipulate individual assignments and tactics)

Service Support

Soldiers will have issued equipment and weapons.

Command & Signal

The Team Leader is in command of the mission. The Team Leader will make all reports and requests to the Platoon Leader. A SITREP is expected upon observing any activity in the assigned Area of Operations and upon completion of the mission.

The primary call signs will be:

Papa Lima-	Platoon Leader
Delta Tango-	Delta Team Leader

(Members of the Fire Team will be issued call signs at the discretion of the Team Leader)

Training Guidelines

General Instructions

COALITION FORCES:
The Battle Master will assume the role of the Platoon Leader for reporting purposes. The trainees will assume roles as members of Fire Team Delta. The trainees will enter into the simulation southeast of the city (Starting Point). The simulation will conclude when all of the trainees arrive at the Rally Point (Ending Point). Other Semi Automated Forces may be included into the simulation as additional Coalition Forces engaging in patrol operations. The trainee's efforts/adherence to the Task Steps and Performance Measures will be documented. The criteria for measuring the trainees' performance are established in FM 7-8, Mission Training Plan for the Infantry Rifle Platoon and Squad.

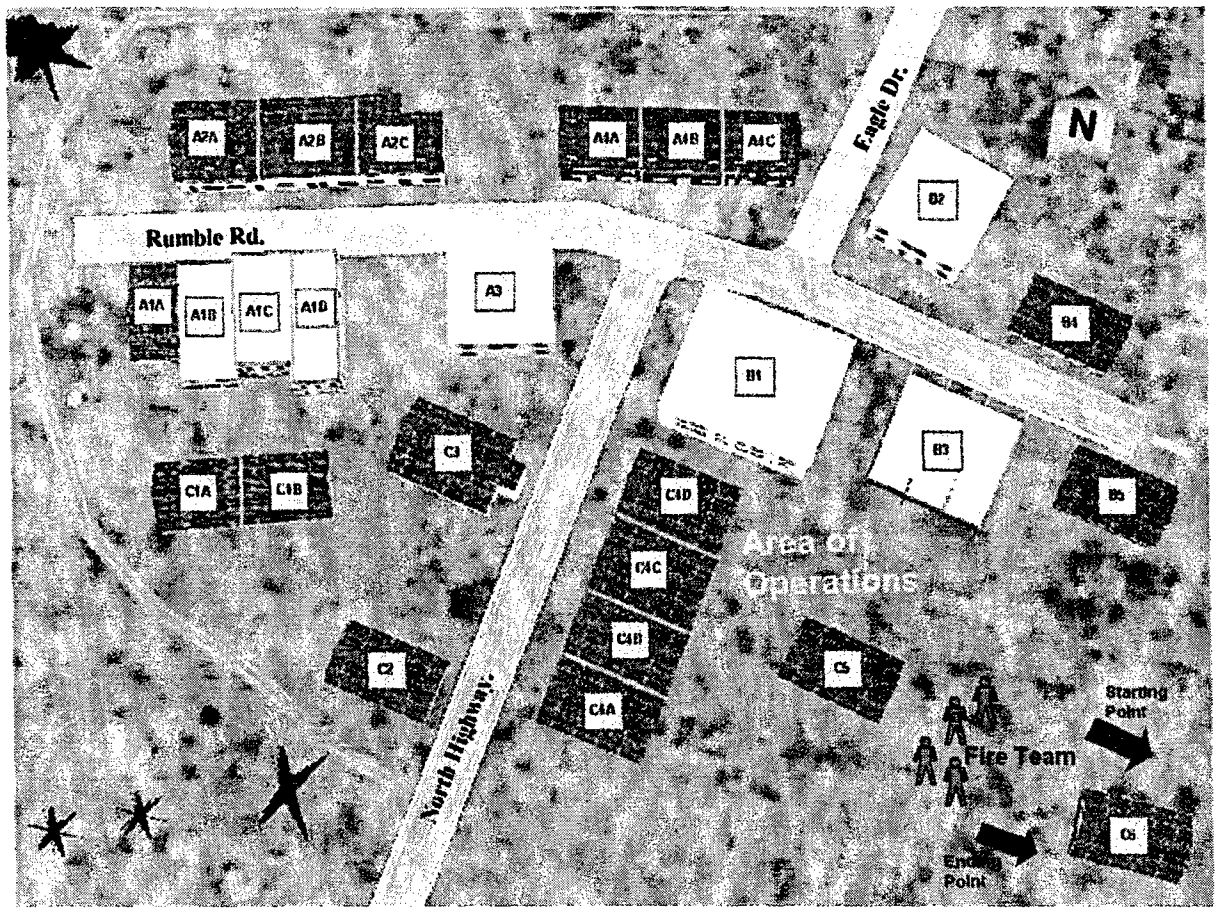

Figure B-1. Mission layout: Level 1 training scenario.

Task Steps and Performance Measures

- Team Leader supervises preparation of the mission.
  - Review OPORD
  - Relay OPORD to Team members
  - Distribute assignments/positions/succession of leadership
  - Plan and establish tactics to be used
  - Lead subordinate trainees
- The squad moves to contact.
  - Maintains geographical orientation
  - Maintains security

Measured Decision Points

This scenario includes 2 measured decision points for the trainees to address. The standard for performance is GO or NO GO.

1. General Orientation- the trainees should move in an easterly direction towards the objective in the simulation.

2. Maintain Security- the trainees should maintain security throughout the simulation. The trainees will not have maintained appropriate security measures if at any time an enemy Soldier approaches within 5 meters or less to the squad.

Training Aid 1

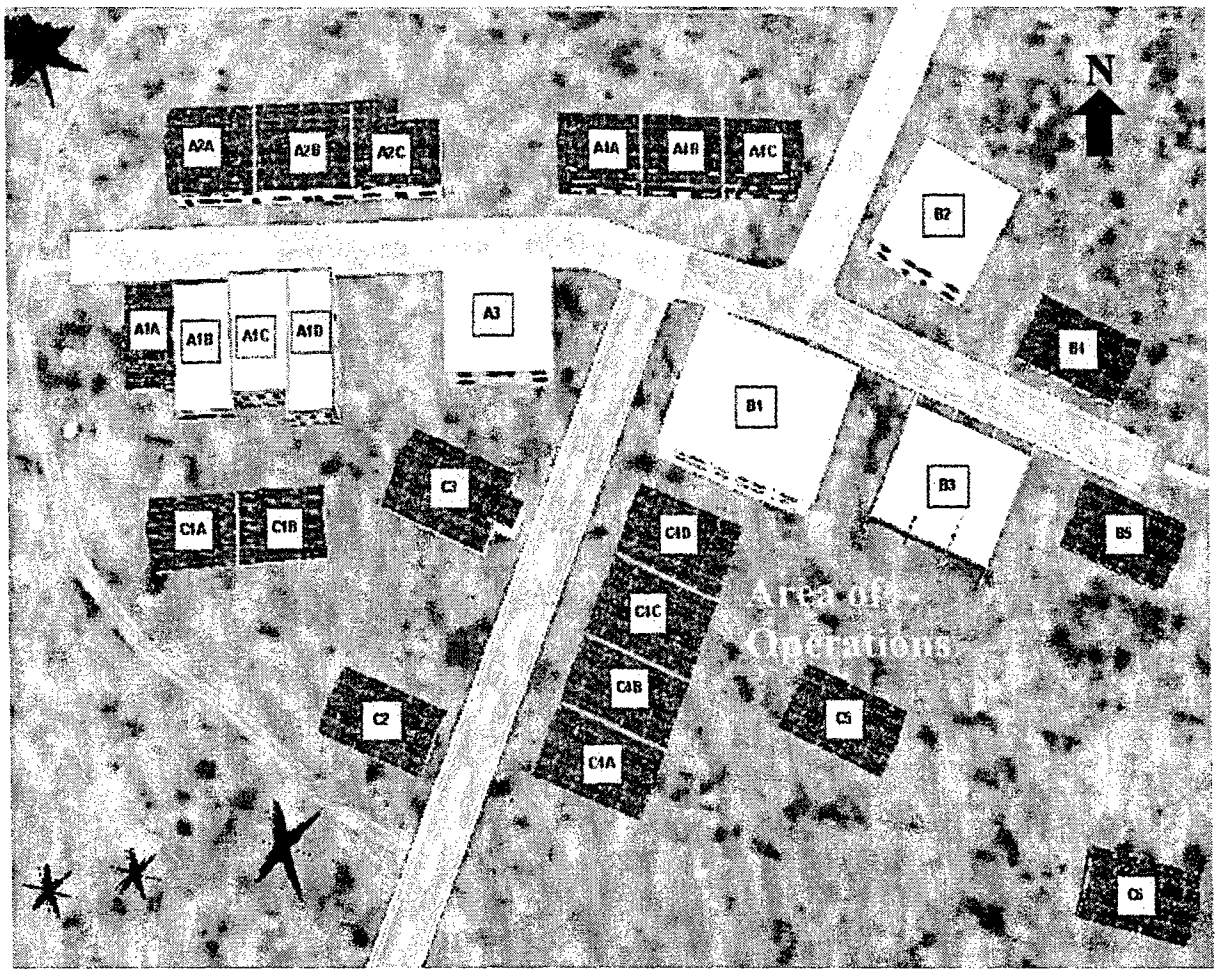

Figure B-2. Terrain map for level 1 training mission.

Appendix C

Level 2 Training Mission

Task Combat Patrol[2]

Conditions

The Fire Team will perform a combat patrol as part of a Coalition Force to support and uphold United Nation interests. The Fire Team is operating separately from its squad and platoon.

Task Standards

The Fire Team must patrol a geographically defined sector of urban terrain and eliminate armed OPFOR. The squad must effectively utilize cover and maintain security throughout the mission. Casualties are not acceptable.

Mission Features

- Requires the management of multiple personnel
- Requires the Use of Force

Operations Order

Situation

OPFOR is categorized as armed and organized military element whose objectives are to undermine UN objectives and disrupt Coalition Force's efforts. OPFOR typically operate independently of command elements in small 3 to 7 member units. OPFOR units utilize guerilla and insurgent tactics and do not require or possess support elements (i.e. air, artillery support, etc.) or equipment (i.e. communications).

Fire Team Bravo will act separately from the squad and platoon and not possess any support. The squad will be dismounted.

Mission

[2] U.S. Department of the Army (September 1994). *Mission training plan for the infantry rifle platoon and squad* (ARTEP 7-8-MTP). Washington, DC: Author.

Fire Team Bravo will conduct a combat patrol of a designated geographical area of the city.

Execution

Fire Team Bravo will act with good judgment in all facets of day-to-day operations. *The Rules-of-Engagement (ROE)* are restrictive. Soldiers will use directed force against armed OPFOR or when necessary to defend themselves or another from serious bodily injury or death. No unwarranted damage to the structures or disruption of the local services will be tolerated.

Fire Team Bravo will patrol the southwest sector of the simulated city in grid W 67, 82. The Team will search for and destroy armed OPFOR units. The Fire Team will begin operations at building C2, adjacent to North Highway, and patrol in a northern direction. Last intelligence received reports that the grid should be void of non-combatants. Fire Team Bravo will conclude operations upon rallying with Alpha Team just north of building A2.

The Team will effectively maintain 360-degree security throughout the mission.

(The Team Leader will stipulate individual assignments and tactics)

Service Support

Soldiers will have issued equipment and weapons.

Command & Signal

The Team Leader is in command of the mission. The Team Leader will make all reports and requests to the Platoon Leader. A SITREP is expected upon encountering OPFOR activity upon arrival at the rally point.

The primary call signs will be:

Papa Lima-	Platoon Leader
Bravo Tango-	Bravo Team Leader

(Members of the Fire Team will be issued call signs at the discretion of the Team Leader)

Training Guidelines

General Instructions

COALITION FORCES:
The BattleMaster will assume the role of the Platoon Leader for reporting purposes. The trainees will assume roles as members of Fire Team Bravo. The trainees will enter into the simulation south of building C2 (Starting Point). The simulation will conclude when all of the trainees arrive at the Rally Point (Ending Point). The trainee's efforts/adherence to the Task Steps and Performance Measures will be documented. The criteria for measuring the trainees' performance are established in FM 7-8, Mission Training Plan for the Infantry Rifle Platoon and Squad.

OPPOSING FORCES:
Between 3 and 7 OPFOR (Semi-automated Forces or additional personnel) shall assume an aggressive role and attempt to eliminate Fire Team Bravo. OPFOR should be grouped and act in two separate elements. One element should be stationed north of building C3 and the other should patrol Rumble Rd. OPFOR elements will not actively seek Fire Team Bravo but will agress them upon contact.

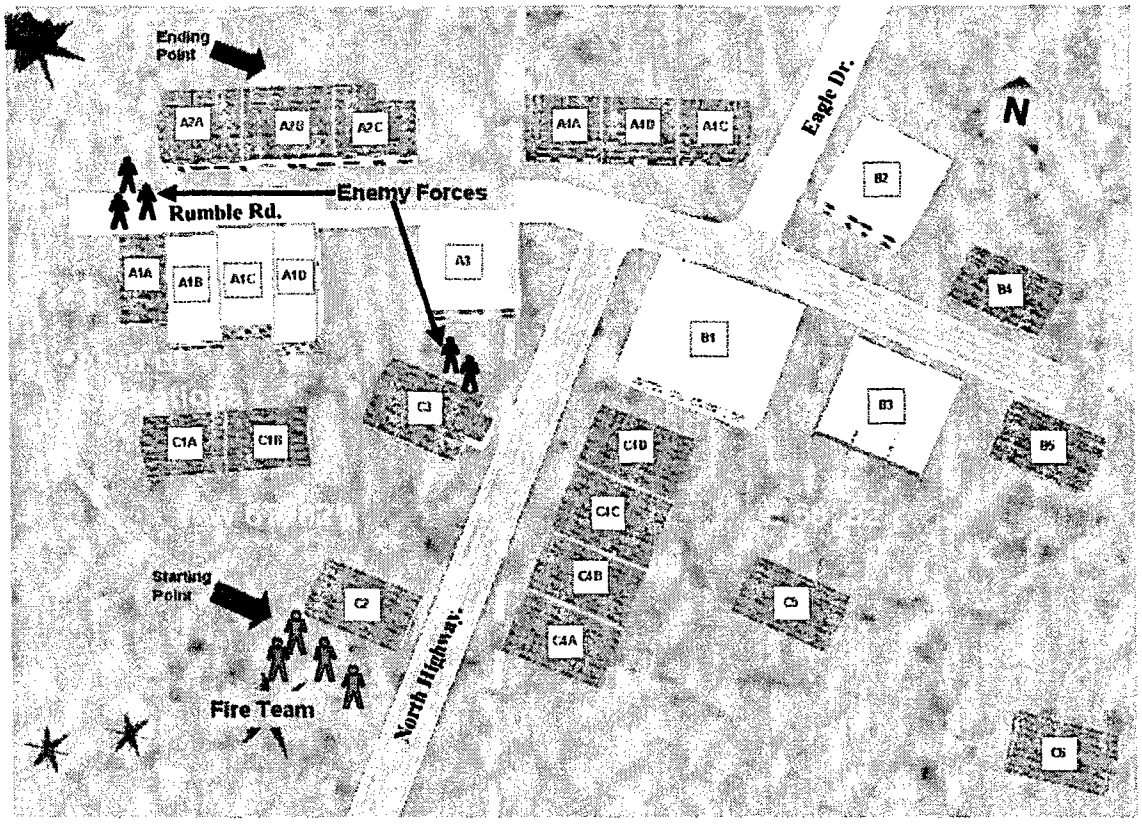

Figure C-1. Mission layout: Level 2 training scenario.

Task Steps and Performance Measures

- Team Leader supervises preparation of the mission.
  - Review OPORD
  - Relay OPORD to Team members
  - Distribute assignments/positions/succession of leadership
  - Plan and establish tactics to be used
  - Lead subordinate trainees
- The squad moves to contact.
  - Maintains geographical orientation
  - Maintains security
  - Locates the enemy without being detected
  - Effectively utilizes cover and concealment
- The squad reacts to contact
  - Engages the enemy
  - Fixes the enemy to a position
  - Maneuvers against the enemy
  - Destroys the enemy

Measured Decision Points

This scenario includes 4 measured decision points for the trainees to address. The standard for performance is GO or NO GO.

1. General Orientation- the trainees should move in a northerly direction towards the objective in the simulation.

2. Maintain Security- the trainees should maintain security throughout the simulation. The trainees will not have maintained appropriate security measures if at any time an enemy Soldier approaches within 5 meters or less to the squad.

3. Use of Cover- the trainees should maintain the use of cover throughout the simulation. No more than 50% of the trainees in the simulation should be without cover at any one time.

4. Takes Action Upon Contact- upon contact the trainees will eliminate the enemy Soldiers. The trainees will locate and maneuver against the enemy until they are eliminated.

Training Aid 1

Mission Map of Terrain

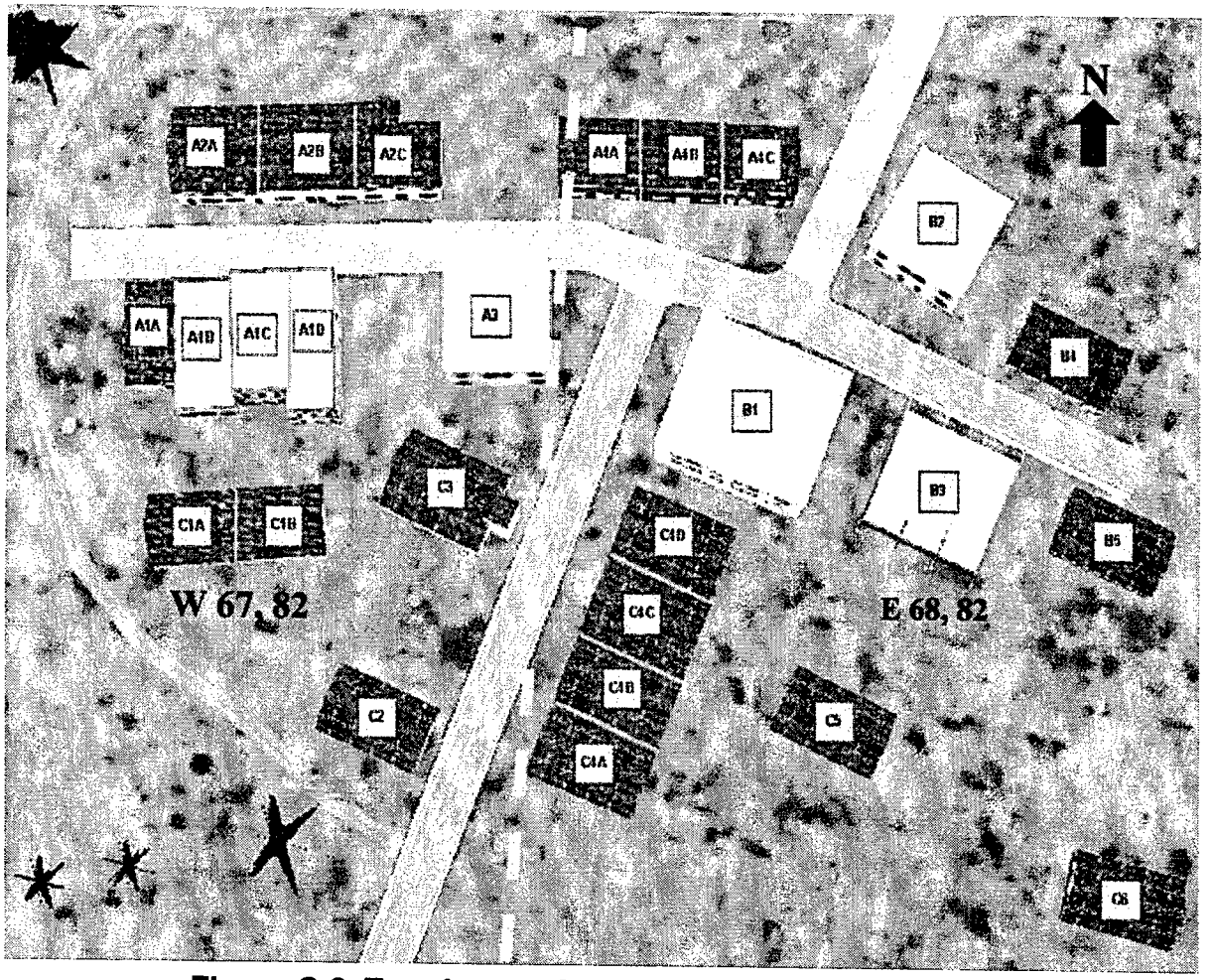

Figure C-2. Terrain map for level 2 training mission.

Level 3 Training Mission

Task Perform Movement to Contact[3]

Conditions

A squad is operating separately from its platoon in a wartime environment. Intelligence has just been received that a small cell of enemy forces is preparing to attack a column of coalition forces.

Task Standards

The squad must intercept and destroy the enemy forces before they attack the column of Coalition Forces. The squad must maintain security throughout the mission. Casualties are not acceptable.

Mission Features

- Requires the use of deadly force
- Requires the management of multiple personnel
- Time constraints exist

Operations Order

Situation

The enemy cell is comprised of approximately six personnel and is equipped with light arms. The cell's intent is to intercept a column of Coalition Forces passing through an urbanized area. The cell will be traveling northwest from the southern boundaries of the city.

Alpha squad will act separately from the platoon and not possess any support. The squad will be dismounted.

Mission

Alpha squad will intercept and destroy the enemy cell before the cell has an opportunity to attack the column.

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[3] U.S. Department of the Army (September 1994). *Mission training plan for the infantry rifle platoon and squad* (ARTEP 7-8-MTP). Washington, DC: Author.

Execution

Alpha Squad will act with speed, stealth and good judgment in all facets of operations. *The Rules-of-Engagement (ROE)* are restrictive in the sense that no unwarranted damage to the structures or disruption of the local services will be tolerated.

The column of Coalition Forces will be traveling through the urbanized area (city) at approximately 0730 hours. Alpha squad will enter the city at 0645 hours from the west and travel east. The Line of Departure (LD) will be east of building C1. The squad must negotiate the abandoned structures and locate and destroy the enemy cell by 0715 hours. The squad will then rally at the intersection of Rumble Rd. and Eagle Dr. to be picked up by a troop transport vehicle in the passing column.

The squad will effectively utilize the cover and concealment supplied by the structures and maintain 360-degree security throughout the mission.

(The Squad Leader will stipulate individual assignments and tactics)

Service Support

Soldiers will have issued equipment and weapons. The Casualty Collection Point (CCP) and Enemy Prisoners of War (EPW) collection point is located at the intersection of Rumble Rd. and Eagle Dr. No supporting units are available.

Command & Signal

The Squad Leader is in command of the mission. The Squad Leader will make all reports and requests to the Platoon Leader. A SITREP is expected after crossing the LD and upon completion of the mission.

The primary call signs will be:

Papa Lima- Platoon Leader
Alpha Sierra Lima- Alpha Squad Leader

(Members of the squad will be issued call signs at the discretion of the Squad Leader)

Training Guidelines

General Instructions

COALITION FORCES:
The Battle Master will assume the role of the Platoon Leader for reporting purposes. The trainees will assume roles as members of Alpha Squad. The trainees will enter into the simulation west of the city (Starting Point). The simulation will conclude when surviving trainees arrive at the Rally Point (Ending Point). The trainee's efforts/adherence to the Task Steps and Performance Measures will be documented. The criteria for measuring the trainees' performance are established in FM 7-8, Mission Training Plan for the Infantry Rifle Platoon and Squad.

OPPOSING FORCES:
Enemy forces will be situated in a loose wedge formation just south of building B5. The enemy will possess small arms. The enemy will shoot at the squad upon seeing them. The enemy's formation will begin to fan out if not destroyed within 10 minutes from the first weapons discharge. An enemy Soldier should appear and attempt to approach the Coalition Forces from the rear while they are actively engaged with the enemy in force.

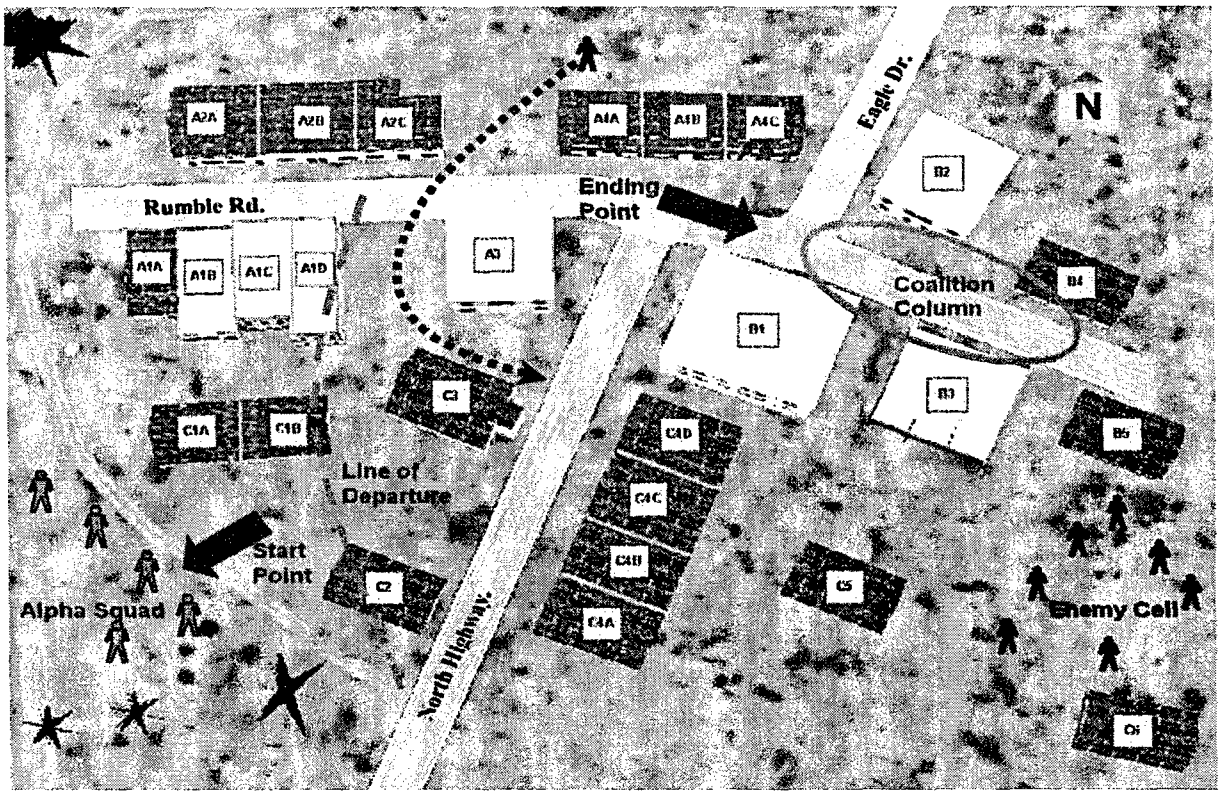

Figure D-1. Mission layout: Level 3 training scenario.

Task Steps and Performance Measures

- Squad Leader supervises preparation of the mission.
  - Review OPORD
  - Relay OPORD to squad members
  - Distribute assignments/positions/ succession of leadership
  - Plan and establish tactics to be used
  - Lead subordinate trainees
- The squad moves to contact.
  - Maintains geographical orientation
  - Utilizes cover and concealment
  - Maintains security
  - Locates the enemy without being detected
- The squad reacts to contact
  - Engages the enemy
  - Fixes the enemy to a position
  - Maneuvers against the enemy
  - Destroys the enemy

Measured Decision Points

This scenario includes 4 measured decision points for the trainees to address. The standard for performance is GO or NO GO

1. General Orientation- the trainees should move in an easterly direction towards the objective in the simulation.

2. Use of Cover- the trainees should maintain the use of cover throughout the simulation. No more than 50% of the trainees in the simulation should be without cover at any one time.

3. Maintain Security- the trainees should maintain security throughout the simulation. The trainees will not have maintained appropriate security measures if at any time an enemy Soldier approaches within 5 meters or less to the squad.

4. Takes Action Upon Contact- upon contact the trainees will eliminate the enemy Soldiers. The trainees will locate and maneuver against the enemy until they are eliminated.

Training Aid 1

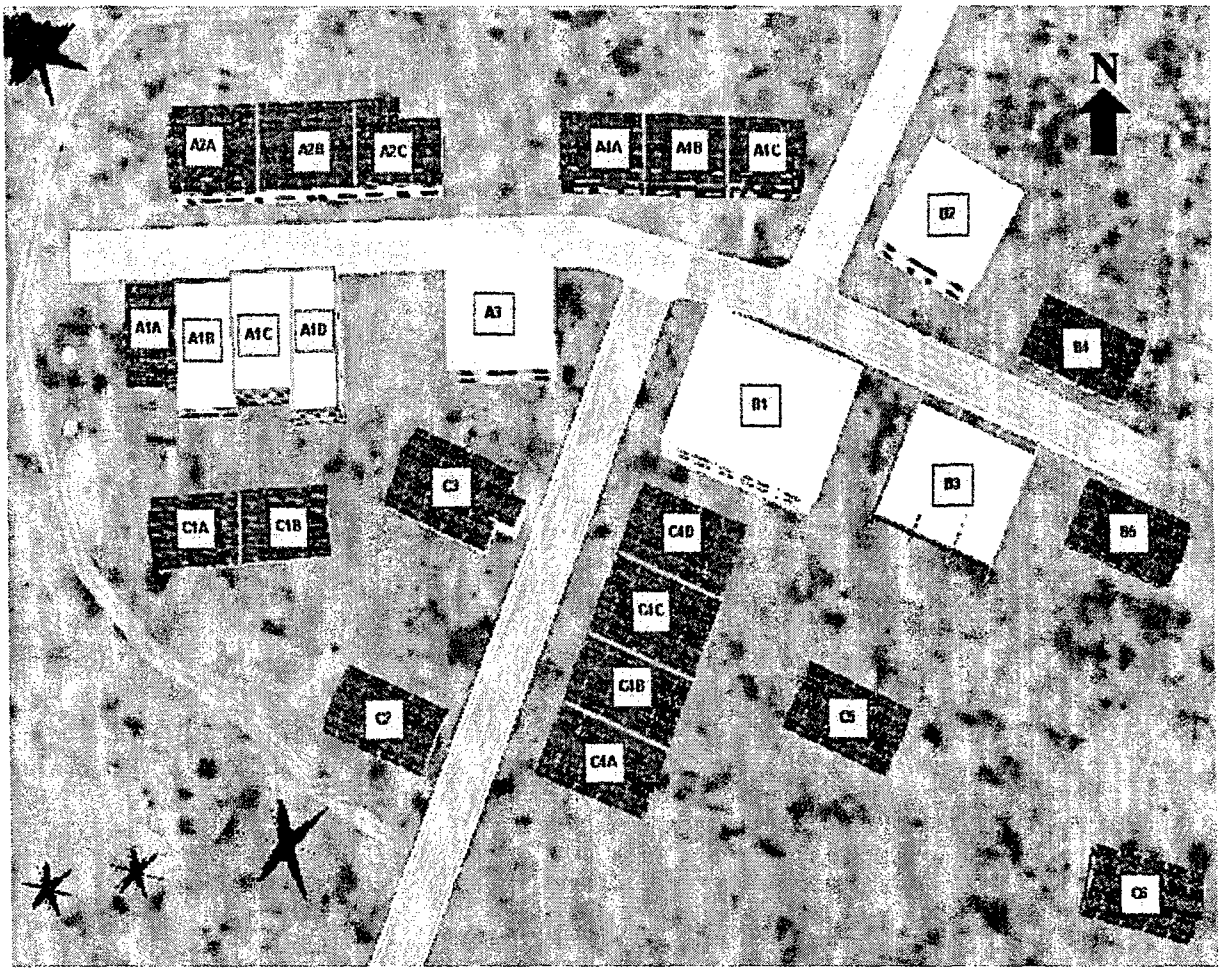

Figure D-2. Terrain map for level 3 training mission.

Level 4 Training Mission

Task Movement to Contact[4]

Conditions

The Squad will perform Movement to Contact during MOOTW.

Task Standards

The Squad must go to a geographically defined sector of urban terrain and eliminate armed OPFOR who are attacking Friendly Forces. The Squad must effectively utilize cover and maintain security throughout the mission. Casualties are not acceptable.

Mission Features

- Requires the management of multiple personnel
- Requires the Use of Force
- Time constraints exist
- Non-Combatants are present

Operations Order

Situation

OPFOR is categorized as armed and organized military element whose objectives are to undermine UN objectives and disrupt Coalition Force's efforts. OPFOR typically operate independently of command elements in small 3 to 7 member units. OPFOR units utilize guerilla and insurgent tactics and do not require or possess support elements (i.e. air, artillery support, etc.) or equipment (i.e. communications).

Alpha Squad will act separately from the platoon and not possess any support. The squad will be dismounted.

Mission

[4] U.S. Department of the Army (September 1994). *Mission training plan for the infantry rifle platoon and squad* (ARTEP 7-8-MTP). Washington, DC: Author.

Alpha Squad will hastily move to support Friendly Forces under attack at a Food Distribution site.

Execution

Alpha Squad will act with good judgment in all facets of day-to-day operations. *The Rules-of-Engagement (ROE)* are restrictive. Soldiers will use directed force against armed OPFOR or when necessary to defend themselves or another from serious bodily injury or death. No unwarranted damage to the structures or disruption of the local services will be tolerated.

Alpha Squad will move to the UN Food Distribution Site located on the ground floor of building C4D.The Site is manned and supported by US and Coalition Forces, namely Echo Squad from your platoon. Alpha Squad will provide support to Charlie Squad who is currently under attack and "fixed" by OPFOR. Alpha Squad will begin movement in two minutes from the Rally Point between building groups A1 and A2 on Rumble Rd.

(The Squad Leader will stipulate individual assignments and tactics)

Service Support

Soldiers will have issued equipment and weapons. The Casualty Collection Point (CCP) and Enemy Prisoners of War (EPW) collection point is located at the intersection of Rumble Rd. and Eagle Dr. No supporting units are available.

Command & Signal

The Squad Leader is in command of the mission. The Squad Leader will make all reports and requests to the Platoon Leader. A SITREP is expected upon arrival at the Food Distribution Site, encountering OPFOR activity and elimination of OPFOR.

The primary call signs will be:

Papa Lima-	Platoon Leader
Alpha Lima-	Alpha Squad Leader

(Members of the Fire Team will be issued call signs at the discretion of the Squad Leader)

Training Guidelines

General Instructions

COALITION FORCES:
The Battle Master will assume the role of the Platoon Leader for reporting purposes. The trainees will assume roles as members of Alpha Squad. Additional personnel or Semi-Automated Forces will assume the role of Echo Squad inside Building C4D. The trainees will enter into the simulation between building A1 and A2 on Rumble Rd. (Starting Point). The simulation will conclude when all OPFOR are eliminated. The trainee's efforts/adherence to the Task Steps and Performance Measures will be documented. The criteria for measuring the trainees' performance are established in FM 7-8, Mission Training Plan for the Infantry Rifle Platoon and Squad.

PPOSSING FORCES:
Between 5 and 10 OPFOR (Semi-automated Forces or additional personnel) shall assume an aggressive role and continually fire on the occupants of building C4D, the Food Distribution Site. OPFOR should be grouped and act in two separate elements. One element should be stationed north of building C5 and the other should should be southeast of building B1.

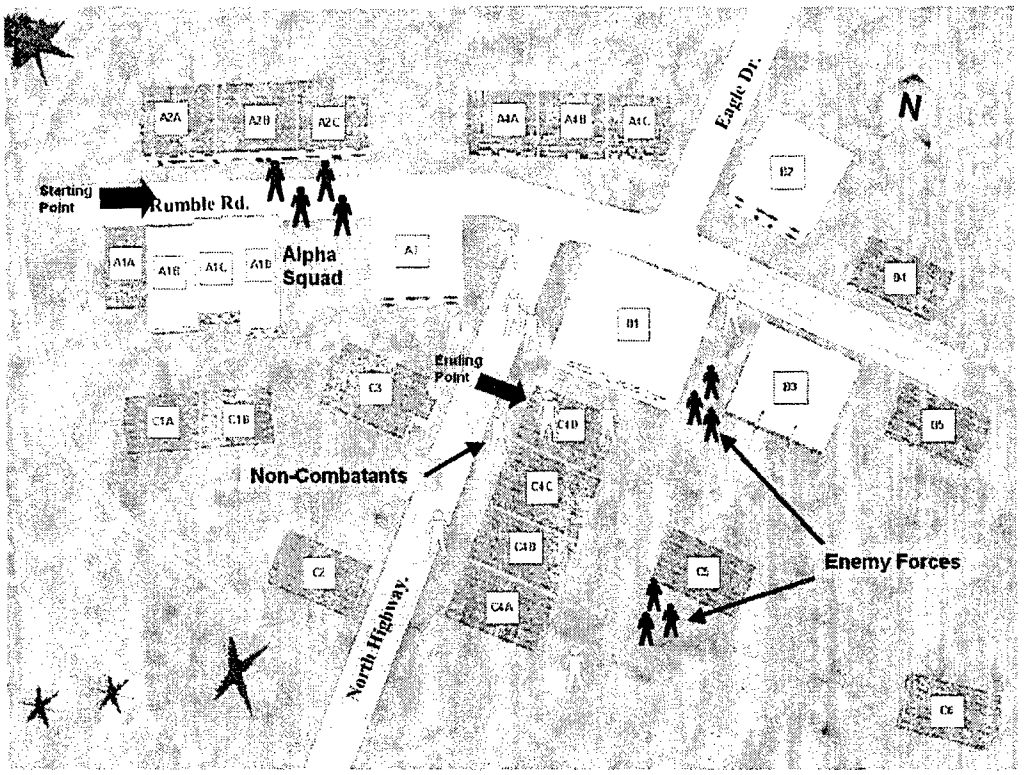

Figure E-1. Mission layout: Level 4 training scenario.

NON-COMBATANTS
Between 5 and 15 Non-Combatants should be moving freely in and around building C4.

Task Steps and Performance Measures

- Team Leader supervises preparation and execution of mission.
  - Review OPORD
  - Relay OPORD to Team members
  - Distribute assignments/positions/ succession of leadership
  - Plan and establish tactics to be used
  - Lead subordinate trainees
  - Assigns each Soldier a target or area to cover

- The squad moves to contact.
  - Maintains geographical orientation
  - Maintains security
  - Approaches from enemy flank or rear.
  - Moves rapidly
  - Secures building entry point
  - Effectively utilizes cover and concealment
  - Moves along routes that do not mask friendly suppressive fires

- Conducts movement after enemy defensive fires are suppressed

- The squad reacts to contact
  - Engages the enemy
  - Fixes the enemy to a position
  - Maneuvers against the enemy
  - Uses direct fire weapons appropriately
  - Destroys the enemy

Measured Decision Points

This scenario includes 2 measured decision points for the trainees to address. The standard for performance is GO or NO GO.

1. General Orientation- the trainees should move in a northerly direction towards the objective in the simulation.

2. Maintain Security- the trainees should maintain security throughout the simulation. The trainees will not have maintained appropriate security measures if at any time an enemy Soldier approaches within 5 meters or less to the squad.

3. Use of Cover- the trainees should maintain the use of cover throughout the simulation. No more than 50% of the trainees in the simulation should be without cover at any one time.

4. Takes Action Upon Contact- upon contact the trainees will locate and maneuver against the enemy until they are eliminated.

5. Use of Force- the trainees will eliminate only OPFOR.

Training Aid 1

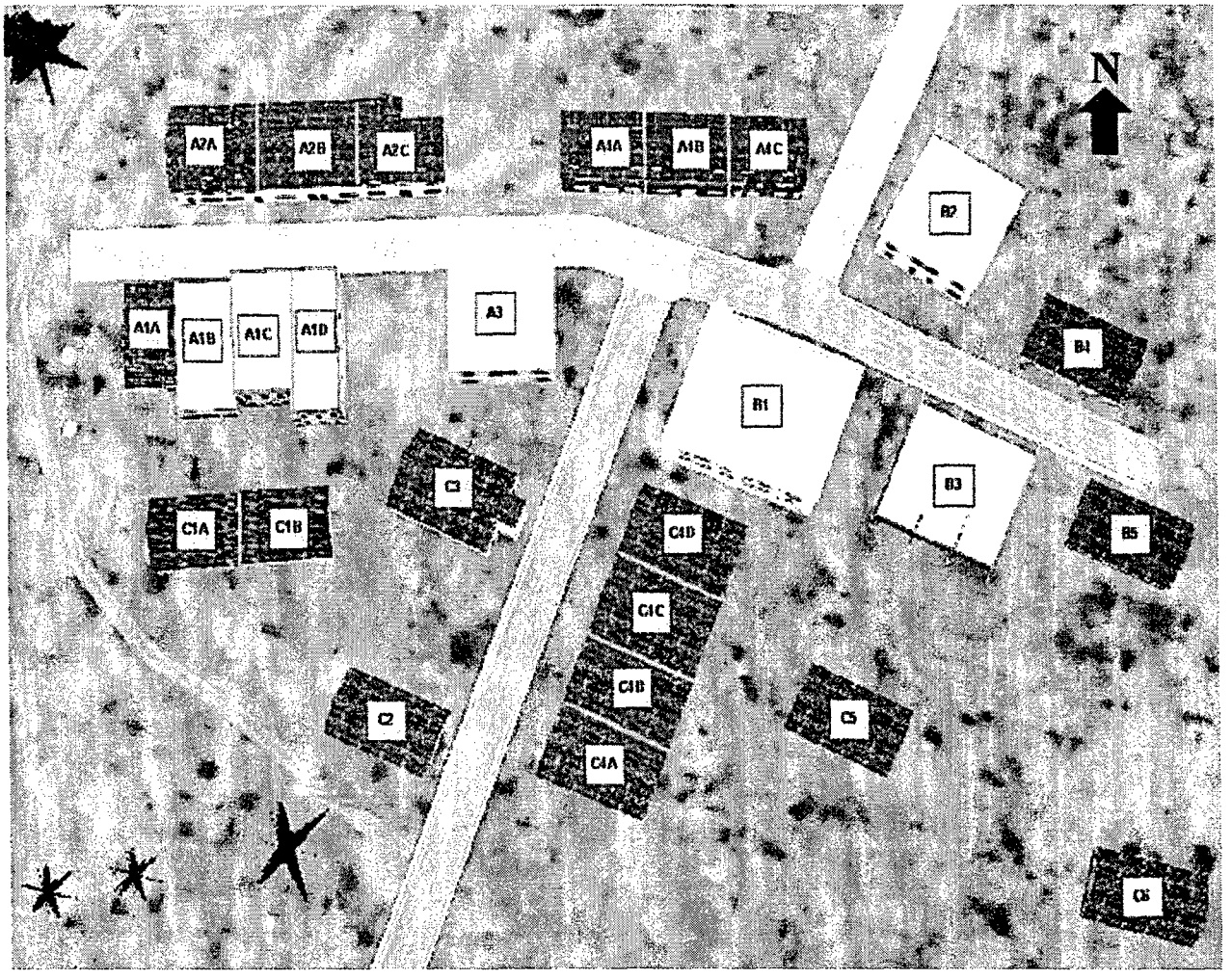

Figure E-2. Terrain map for level 4 training mission.

APPENDIX F

VISSA SCENARIO AUTHORING &
OPERATOR TRAINING
PRESENTATION

SCENPRO

Scenario Authoring And Operator Training

ViSSA

VIRTUAL SOLDIER SKILLS ASSESSMENT SYSTEM

1

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ViSSA Author / Operator Training – Agenda

- Overview of ViSSA System
- Phases of Operation
- Assessment Rule Authoring
- Pre-Exercise Setup Tasks
- O/C Tasks at Exercise Start
- O/C Tasks during Exercise
- O/C Tasks at Exercise End
- Post-Exercise Tasks
- ViSSA Object Model
- VB Script
- Advanced Techniques

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ViSSA Demonstration Sequence

- **Description of three applications**
- **Description of Training Exercise Authoring Methodology**
- **Use of DISAF (Terrain, SAFs, Overlays)**
- **Use of ViSSA Assessment (Properties, Terrain, Overlays, Unit Hierarchy, Observations, ECA Rules)**
- **Exercise**
  - Start DISAF and ViSSA Application Suite
  - Load scenarios

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Overview of ViSSA System

- The Virtual Soldier Skills Assessor is a software suite that works in conjunction with DIS/HLA soldier, tank, and aircraft simulations.
- ViSSA monitors soldier movement and behavior in a virtual environment and compares it against a standard (that is defined by a trainer, commander, O/C, or Battlemaster).
- As a soldier moves through a virtual world executing a mission, ViSSA assesses his or her skill (against the standard) at different points and records specific instances of good or poor skills and/or decision-making.
- ViSSA can be used at the conclusion of soldier training to ensure that the soldier has a high degree of skill for specific tactics and procedures.

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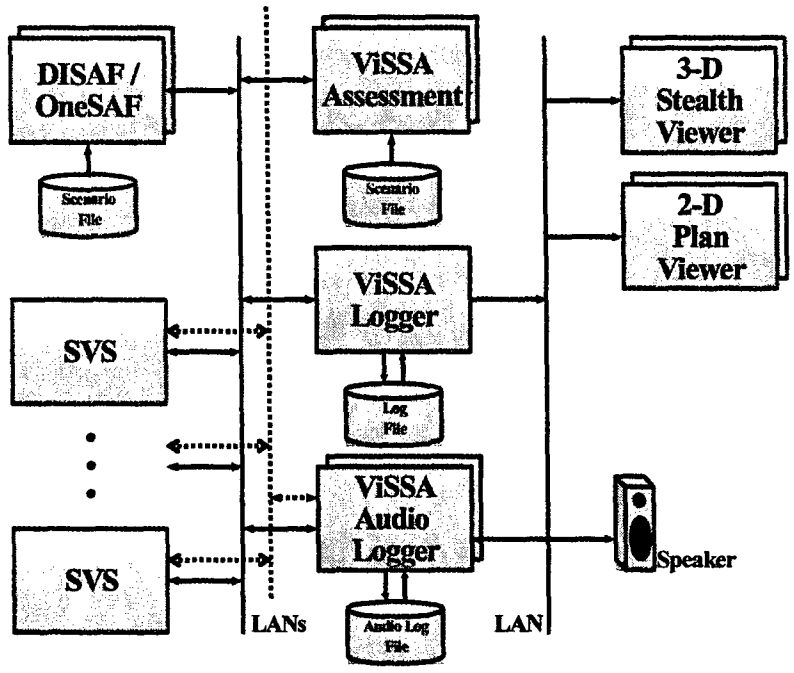
ViSSA Components



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ViSSA Operation

- **ViSSA operates by monitoring the message traffic that moves between separate simulation systems.**
- **This message traffic specifies what the solder, tank, or aircraft is doing – such as moving, firing a weapon, or using the radio.**
- **ViSSA uses this message traffic in three ways:**
  - **Observe**
    - Certain assessments can be made simply by examining the contents of a message
    - Is the soldier aiming the weapon?
  - **Compute**
    - Some assessments can be made by making small calculations between different messages
    - How long did it take the team leader to report that his team was under fire?
  - **Infer**
    - It is possible to infer certain mental processes by observing complex soldier behavior
    - If the team members cross the square one at a time, then infer that the team leader recognized that there may be an ambush.

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ViSSA Assessment

- **ViSSA assesses soldier skills by evaluating Rules (that are created by a trainer, commander, O/C, or Battlemaster)**
- **Rules are created in the form of Event-Condition-Action (ECA)**
  - Events cause the rules to be evaluated
  - Events include the soldier moving, using a weapon, using the radio, and getting wounded
  - Conditions are tests on details of the events or the state of the virtual world
  - Conditional tests can be made on the soldiers location, speed, orientation, force, unit, role, etc.
  - Actions are performed if the conditions are true
  - Actions include indicating good or poor skill, setting a global variable, starting a timer, and ordering a SAF into action

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Phases of Operation

Before the Exercise

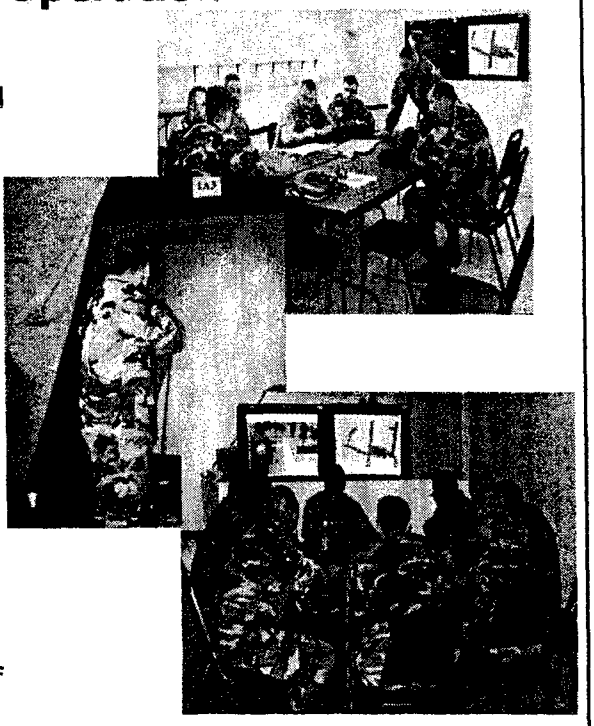
- ViSSA Assessment Module acts as the Training Exercise Authoring Tool to aid the Trainer, O/C, Commander, or Battlemaster in creating Event/Condition/Action Rules to monitor soldier movement and behavior to assess decision-making

During the Exercise

- ViSSA Assessment Module evaluates Event/Condition/Action Rules against soldier movement and behavior
- ViSSA Logger Module captures and stores all relevant PDUs (including Mark-Timeline) during the exercise

After the Exercise

- ViSSA Logger Module is used to play back exercise PDU/Logged data
- Logger Module GUI displays each of the Mark-Timeline PDUs to focus AAR activities on the key decision points of the mission



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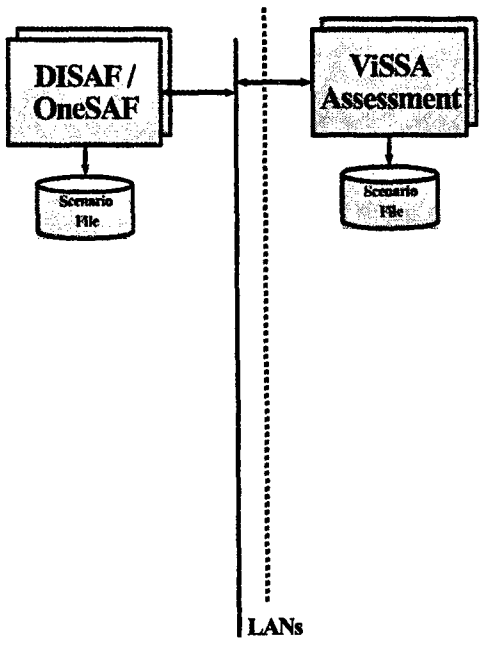
ViSSA – Before the Exercise



Before to the exercise, the Training Exercise Author uses ViSSA Assessment and DISAF/OneSAF to create a scenario. Products include:

- *** DISAF/OneSAF Scenario File**
  - **- SAFs**
  - **- Overlays (Points, Lines/ Routes, Areas)**
  - **- Triggers**
- *** ViSSA Scenario File**
  - **- Unit Hierarchy**
  - **- Observations**
  - **- E/C/A Rules**

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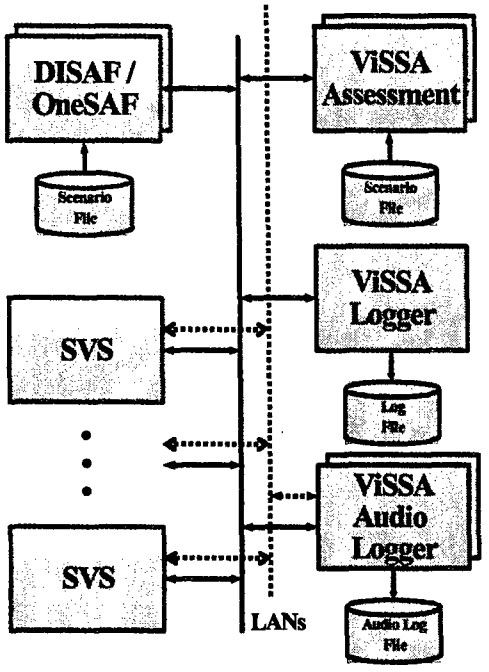
ViSSA – During the Exercise



During the exercise, ViSSA Assessment monitors PDU traffic, raises Events, evaluates Conditions, and executes Actions (including generating MarkTimeline PDUs).

The ViSSA Logger and Audio Logger capture all (relevant) PDU traffic, compute statistics, and store data in Log Files.

ViSSA Logger also provides O/C with a method for entering an Observation.

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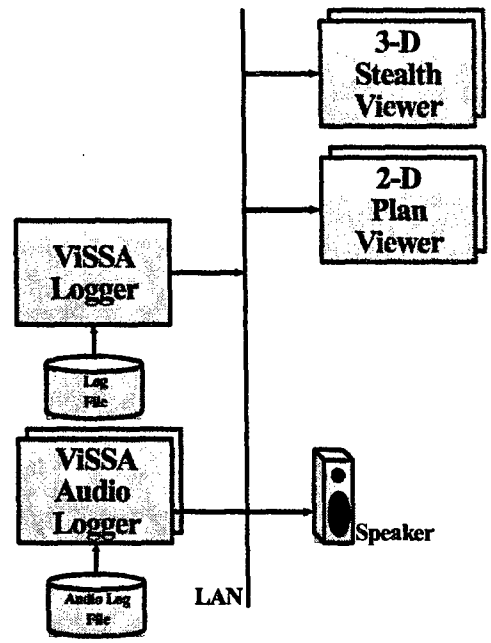
ViSSA – After the Exercise

After the Exercise, the ViSSA Logger and Audio Logger play back the logged PDU traffic, broadcast this traffic on the LAN for use by Viewers, and displays the ViSSA Decision-Making Assessment marks.



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Training Exercise Authoring

- ViSSA requires a standard against which to assess soldier skills and decision-making
- Creating a "ViSSA scenario" is be done prior to the execution of an exercise – at the same time as the Mission Briefing, OPORD, and DISAF/OneSAF scenario are created
- The Training Exercise Authoring Methodology (TEAM) is a sequence of tasks that produce a ViSSA scenario
- The following slides show the high-level steps of the Methodology

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Training Exercise Authoring Methodology

1. **Identify Soldier Skill(s) being assessed**
2. **Review source of soldier knowledge**
   a. Training Material
   b. Documentation
3. **Enumerate a set of situations that cover the scope of the skill**
   a. Just barely requires skill
   b. Requires adequate/typical level of skill
   c. Requires total skill mastery
   d. Special cases
4. **Create a scenario, with believable context, to stress one or more of the situations. This will likely be in the 5-paragraph OPORD format.**
5. **Determine expected soldier actions within the scenario**
   a. Under trained
   b. Typical
   c. Expert

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Training Exercise Authoring Methodology

6. **Indicate key decision points within the scenario relative to the skills being assessed**
7. **Identify observable actions that can be used to quantify the soldier's application of the skill being assessed**
8. **Determine, in conjunction with the O/C, how to capture each action**
   a. Directly Observable with PDUs
      i. Motion of Soldier or SAF into or out of Inclusion or Exclusion Area
      ii. Motion of Soldier or SAF across Phase Line
      iii. Fires by Soldier or SAF
      iv. Wound/Kill of Soldier, Teammate, or SAF
      v. Radio Transmission by Soldier or O/C
      vi. Exercise Time (minutes since the start of the exercise)
   b. Computable
      i. Reaction Time (time between one action and another)
      ii. Facing (when two entities CAN see each other)
      iii. Distance (between soldier and target or rallypoint)

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Training Exercise Authoring Methodology

8. Determine, in conjunction with the O/C, how to capture each action **(continued)**
   c. Inferable
      i. Team Behavior (over march, covering fire, coordinated assault)
      ii. Complex Routes (to avoid kill zones)
      iii. Sophisticated use of Weapons (smokes and flash-bangs)
9. **Create a new scenario in DISAF/OneSAF**
   a. Lay down forces (Friendly, Neutral, Enemy)
   b. Create Overlays and enter required points, lines, areas, and SAF triggers – annotate each
10. **Create new scenario using ViSSA Assessment Module**
   a. Specify which forces are SAF and which should be Assessed
   b. Specify specific Observations the O/C can make during exercise
   c. For each E/C/A, include Socratic questions to support AAR
11. **Create an OPORD to give to the soldier prior to entering the SVS**
12. **Create instructions for the O/C**

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Creating E/C/A Rules

- Steps 8 and 10c of the Methodology result in the creation of the Event/Condition/Action Rules
- In order for ViSSA to "evaluate" these Rules, they must be provided in a "computer readable format"
- We have selected Microsoft's Visual Basic Script, or VB Script, to represent the E/C/A Rules.

- In order for E/C/A Rules to be evaluated, there Assessment system must receive an Event...such as an Entity Movement or a Radio Transmission.
- The Conditional part of the E/C/A Rules associated with that event are then evaluated (using a VB Script engine).
- Any time the Conditional part of an E/C/A Rule evaluates to TRUE, the Action(s) are executed.

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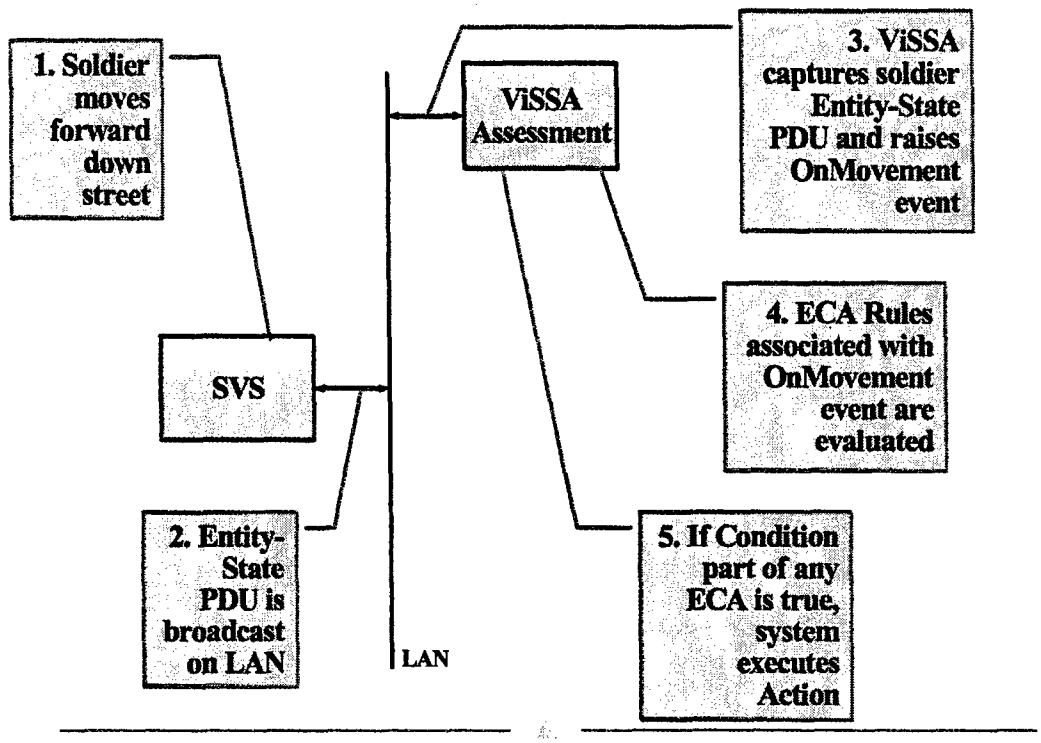
Event/Condition/Action Rule Evaluation Example



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Event/Condition/Action Attributes

- **Events**
  - StartEx
  - OnMovement
  - OnFire
  - OnDetonate
  - OnTransmit
  - OnObservation
  - OnTimer
  - OnTimerAbort
  - EndEx
  - OnHealthChange
  - OnWeaponChange
  - OnPostureChange
  - OnPDUReceived
  - OnStat
  - OnHit, OnWound
  - OnKill
- **Conditions**
  - Phase
  - ElapsedTime
  - Property
  - Health
  - Point
  - Line
  - Area
  - Distance
  - Orientation
  - Posture/Weapon
  - Force/Unit/Roles
  - Participation
  - Stats
  - Radio Transmission
  - Timer Status
- **Actions**
  - Set Phase
  - Set Property
  - Capture Location
  - Mark Timeline
  - Start Timer
  - Cancel Timer
  - Order SAF

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Event/Condition/Action Example

- **Description:** If soldier moves into Kill Zone (area outside window of hostage site), then Mark-Timeline and cancel CircleBuildingQuickly timer
- **Requirement:** An area named "KillZone" must have been defined on an Overlay in DISAF/OneSAF
- **Event:**
  - OnMovement
- **Condition:**
  - Set KillZone = Areas("KillZone")
  - If (KillZone.IsIn(Entity.Location)) Then
- **Action:**
  - MarkTimeline ("Poor", Entity.Callsign, "Entered Kill Zone")
  - Timers("CircleBuildingQuickly").IsEnabled = False

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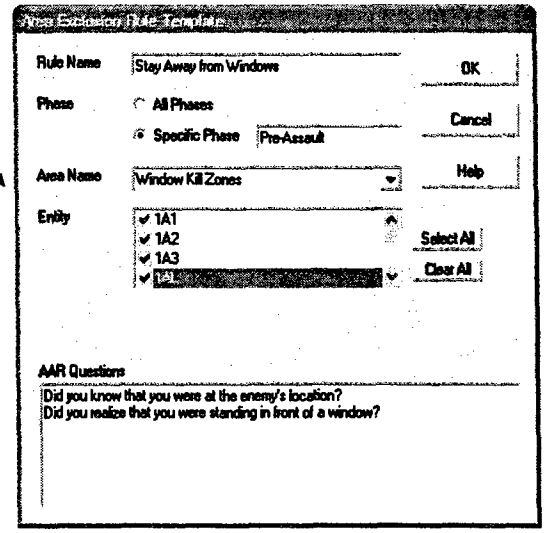
E/C/A Assessment Rule Authoring

- **There are currently three ways to create E/C/A Assessment Rules**
  - Use the Rule Templates in the ViSSA Assessment Module (which produce VB Script)
    - Fratricide Rule
    - Area Exclusion Rule
    - Fire Reaction Rule
    - Observation Rule
  - Copy VB Script from supplied examples
  - Write VB Script



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Writing VB Script

- **ViSSA supports the Microsoft standard Visual Basic Script language (VB Script)**
- **VB Script has access to the ViSSA Object Model – a large data structure storing key fact about the mission and the entities (soldiers, SAFs, tanks, etc.)**
- **Most VB Script will be associated with one of the Events (OnMovement, StartEx, etc.) and be put within that Event's handler**
- **There are five powerful concepts that should be considered when creating rules (see next slides)**
  - Phase
  - Overlays, Points, Lines, and Areas
  - Entities
  - Properties
  - Timers

SCENPRO

Phase

- **Exercises are always in one (and only one) Phase.**
- **The Phase when every exercise starts is "Initial."**
- **The Phase when every exercise ends is "Final."**
- **Changing the Phase is an Action available to all ECA rules.**
- **You can call a Phase anything – although, like most string variables in VB, it is best to avoid spaces and other non-alphanumeric characters.**
- **Typical Phase names are: Ingress, Recon, Stage, Rally, OverMarch, Raid, ClearBuilding, Defend, and Egress.**
- **To test the Phase in the Condition part of an ECA Rule, use the VB Script**
  - If (Phase = "Rally") Then
- **To change the Phase, use the VB Script**
  - Phase = "NewPhaseName"

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Overlays, Points, Lines, and Areas

- **Using DISAF/OneSAF, it is possible to place an Overlay over the battlefield and then drop Points, Lines, and Areas onto the Overlay**
- **Each Overlay has a name, such as ExclusionZones**
- **Points are a single spot on the battlefield, Lines can be one or more segments, Areas are a series of line segments that form a closed polygon**
- **Each Point, Line, and Area has a name, such as RallyPoint, PhaseLineAlpha, and KillZone**
- **Points, Lines, and Areas are often used in the Conditional part of ECA Rules**
- **ViSSA has a number of built-in functions using these Overlay objects**
  - If (Distance(RallyPoint.Location, Entity.Location) < 5.0) Then
  - If (PhaseLineAlpha.HasCrossedLine(ATL.Start, ATL.Location)) Then
  - If (KillZone.IsIn(Tank1.Location)) Then

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Entities

- **There are many Entities in a typical DIS/HLA simulation including**
  - Humans in a Soldier Visualization Station (SVS)
  - Humans at a desktop SVS
  - SAFs produced by DISAF and/or OneSAF
  - Tanks
  - Aircraft
  - Furniture and other non-human, non-vehicle objects
- **ViSSA Assessment can reason about all Entities except the non-human, non-vehicle objects**
- **In VB Script, entities are accessed by their Callsign**
  - Set ATLEntity = Entities("ATL")
  - If (Entities.Force <> "Enemy") Then
- **Many rules are restricted to particular Entities or particular groups of Entities (i.e. only Friendly forces, or only members of Squad A)**

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SCENPRO

Properties

- **ECA Rule Authors often must store variables**
- **ViSSA Assessment allows Authors to store variables as Properties on other objects**
- **Properties are stored as the Variant data type**
- **Properties can be used in the Conditional part of ECA Rules**
  - If (ATL.Properties("Wounded") = False) Then
- **Properties can be set or changed in the Action part of ECA Rules**
  - ATL.Properties("TimeToReachObjective") = 25.7
- **The following ViSSA objects can store properties**
  - ViSSA, Timers/Timer
  - Entities/Entity, EntityRole
  - Forces/Force, Units / Unit , Roles/Role
  - Overlays/Overlay, Points/Point, Lines/Line, Areas/Area

SCENPRO

Timers

- **ViSSA supports Timers – as implemented by Windows**
- **Timers can be created with a "timeout" at any number of seconds from 1 to 64 (with millisecond resolution)**
- **When a Timer is started or re-enabled, a separate process will count down the proper number of milliseconds and then raise the timer event: OnTimer**
- **To test a Timer in the Condition part of an ECA Rule, use the VB Script**
  - If (Timers("R5SeekCoverTimer").IsEnabled = True) Then
- **To create a running Timer, use the VB Script**
  - Timers.Add " R5SeekCoverTimer ", 10.0, True
- **To start/reset a Timer, use the VB Script**
  - R5SeekCoverTimer.IsEnabled = True

SCENPRO

Events and their Arguments

Event	Arguments
OnStartEx	
OnMovement	Entity
OnFire	Shooter, PossibleTarget, Weapon
OnDetonate	Shooter, PossibleTarget, Weapon, Result
OnHealthChange	Entity, Shooter, Weapon, Health
OnTransmitChange	Entity, State
OnPostureChange	Entity, State, Change
OnWeaponChange	Entity, OldWeapon, NewWeapon
	Entity, Stat
	Entity, Target, Weapon
	Entity, Shooter, Weapon, Health
OnObservation	Name, Count
OnTimer	TimerName
OnTimerAbort	TimerName, Reason
	PDU
OnEndEx	

	Implemented
	Not yet implemented
	Possible future feature

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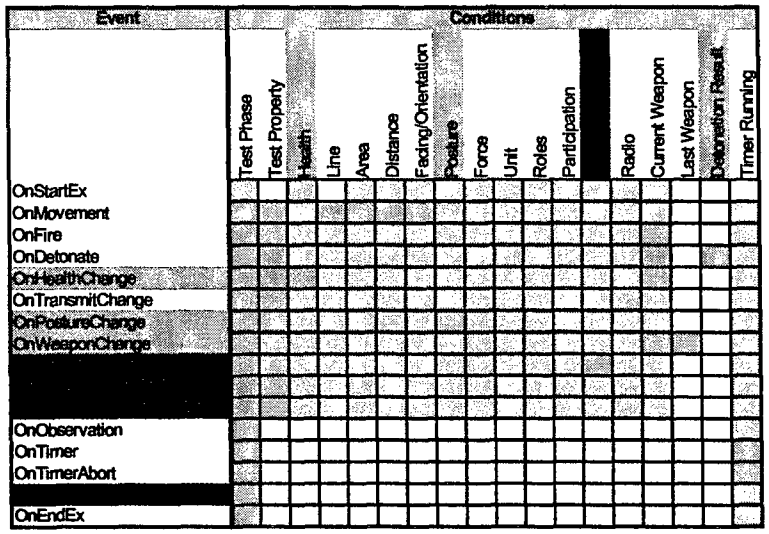
Conditions by Event Type



	Definite, obvious use of this condition within this event
	Straightforward use of this condition within this event
	Conceivable use of this coindition within this event
	Can't/Wouldn't use this condition within this event

	Implemented
	Not yet implemented
	Possible future feature

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Actions

Actions
Set a Property (including VB mathematics and string functions)
Capture a Location, Radio, Weapon, Stat (in a property)
Set Phase
Mark Timeline
Start a Timer
Cancel a Timer
Order a SAF

	Implemented
	Not yet implemented
	Possible future feature

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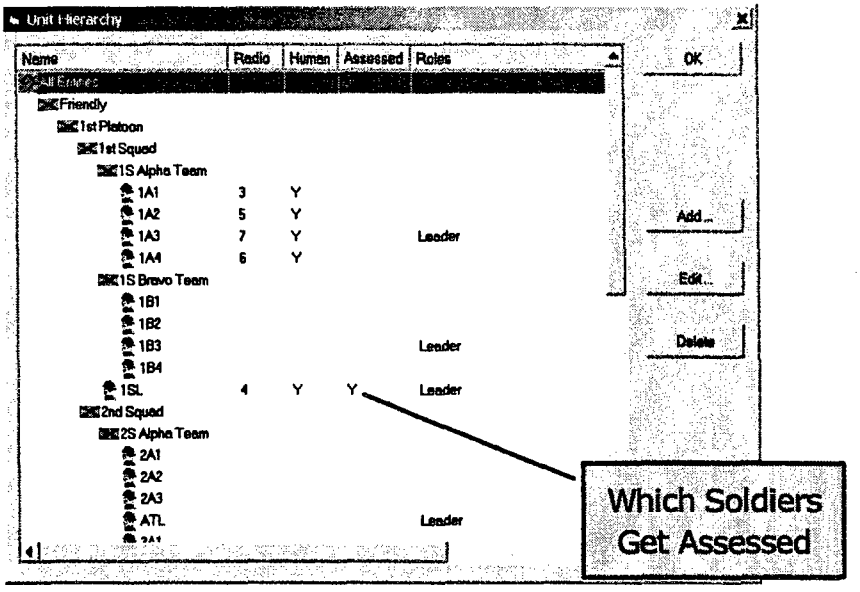
ViSSA Assessment Module – Unit Hierarchy Editor/Viewer



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Appendix G

BattleMaster Capabilities Assessment Questionnaire (including SBL BattleMaster responses from November 7, 2003)

Item ID	Evaluation Statements:	Strongly Agree	Agree	Neither Agree or Disagree	Disagree	Strongly Disagree
	Assessment					
1	The ViSSA training exercise rule templates were easily reviewed for evaluation and appropriateness to the training objectives and soldier level of experience.	2	1			
2	Using the Training Scenario Development Methodology was helpful in developing the training exercise.		3			
3	The ViSSA Assessment Tool allowed the training exercise created to be well customized to the training objectives.	1	2			
4	The training exercise rule templates allowed significant events to be captured and assessed for review during AAR.	2	1			
5	The ability to change stealth viewing locations for phases of the exercise or significant events during the AAR enhances the ability to demonstrate good or poor decision-making.	2		1		
	The positioning of icons or markers along a timeline to identify the timing of significant events was very helpful in conducting an AAR.	3				
6	Defining exercise assessment rules was easily performed.	3				

Item ID	Evaluation Statements:	Strongly Agree	Agree	Neither Agree or Disagree	Disagree	Strongly Disagree
	Exercise Monitoring					
7	Initiation of exercise recording was easily performed.	3				
8	Exercise recording status was easily determined.	3				
9	The manual insertion of good & poor decision points and discussion point annotations was easily performed.	3				
10	The status indicator that audio recording was taking place during the exercise was easily understood.	2	1			
	AAR Analysis & Review Support					
11	The recorded training exercise session data for AAR playback analysis was easily located and selected.	3				
12	The control of exercise playback was easily performed and observations / annotations were easily accessed.	3				
13	Key exercise decision points and discussion points were easily identified and demonstrated to the group.	3				
14	Critical event capture, marking and assessment was automatically performed as specified.	3				

15	Visual playback of the simulated environment and participant actions around key exercise decision points and observations appeared as it did in the exercise and was properly synchronized to the exercise timeline.	3				
16	Navigation and auto-teleportation to desired visual playback time segments and viewing perspectives (teleporting between stealth location views, selected 1st person - shooter & victim - views, overhead 3rd person views) were easily performed.	3				
17	The exercise statistics collected and displayed were correct and useful to the AAR.	2	1			
Item ID	**Evaluation Statements:**	**Strongly Agree**	**Agree**	**Neither Agree or Disagree**	**Disagree**	**Strongly Disagree**
18	The ability to repeatedly loop through decision points / selected segments of the exercise increased AAR effectiveness.	2				
19	The variable playback speed capability worked smoothly and made AAR more effective.	2				
21	The time required to process PDU packets to create Exercise Monitoring logs and Summary Statistics for the AAR is reasonable and does not impact or delay the AAR.	2				

22	**AAR Radio Communications Playback** The training exercise data for communications playback was easily located and selected.	2				
23	The communications sources and recipients were easily identified on the user interface and provided valuable capabilities to the BattleMaster.	2				
24	The time segment of communications playback was correctly synchronized to the exercise timeline.	2				
25	The audio received during playback was of sufficient quality and sufficient loudness to be easily understood by the group.	2				
26	The playback of communications was easily stopped and restarted.	2				

Item ID	Evaluation Questions:
27	What additional capabilities are needed for scenario rule development, event capture, creation and management?
28	Which AAR functions need enhancement to improve training and mission readiness?

29	What improvements to the ViSSA user interfaces and information display methods could greatly improve training effectiveness?	* Drag and Drop * Sort by category * Select All / Deselect All
30	What changes or additions to the Training Scenario Development Methodology would improve your ability to create highly effective training exercises?	